



A macro-econometric model for Lithuania LITMOD

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A Macro-Econometric Model for Lithuania

LITMOD

December 2003

Preface

This report presents theoretical considerations and analyses of past developments related to the formulation of a macro-econometric model of the Lithuanian economy called LITMOD. In addition, a few analyses using the model for simulation of scenarios are included.

The purpose of the model is to describe the structure and the short to medium-term development in Lithuanian economy, to secure internal consistency in economic analyses and to assist a structured thinking on economical development and policy issues.

The work presented in the report is part of a Danish/British Energy Pre-Accession Project for the Lithuanian Ministry of Economy supported by the Danish Energy Authority and the British Department of Trade and Industry. A focus in the overall project is the development of the energy consumption. However, to obtain reliable forecasts of energy demand, reliable forecasts of the economical development in sectors are needed. The present model is a further development of the LITMOD developed within the Ministry of Economy and the Authors are very grateful for the support and kind assistance from State Secretary Gediminas Miškinis and Head of Economy Development Policy Division Arvydas Kazlauskas. The Ministry of Economy has the authority to use and distribute the present model to potential users.

To be useful, economic models and especially econometric models need regular revisions, updating, and re-estimations. The present version of LITMOD may be seen as one step in developing applicable macro-economic models for Lithuania. The present model is useful for general analyses of the Lithuanian economy. However, for more detailed analyses, a further disaggregation of parts of the model is required as well as the inclusion of additional submodels. In addition, as further data becomes available, the basis for the description of individual model parts and equations may be changed to become more realistic, thus making the modelling more reliable. Growing interest to mathematical modelling of the Lithuanian economy, to which LITMOD makes a positive input, recently led to the formation of the LEMM project at Vilnius University. The LEMM project is carried out in collaboration between the Institute of Economics and the Institute of Mathematics and Informatics and will during the next three years, aim to develop a multipurpose set of models for detailed analysis and forecasting of the Lithuanian economy. LITMOD may serve as a starting point in the development of at least some components of the LEMM project.

Project Director Frits Møller Andersen

Professor Eduardas Vilkas

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1. Introduction

LITMOD is a small medium-term demand-driven Keynesian macro-economic model of the Lithuanian economy, including elements of supply-side modelling. The model is estimated on quarterly national account data. A first version of the model was developed within the Lithuanian Ministry of Economy in a Phare Twinning project by Arvydas Kazlauskas and August Leppä.¹ The model mainly determines the real flows of the Lithuanian economy with a 12-sector input-output table as a central element. The purpose of the model is to describe the general development and structure of the Lithuanian economy. The first version of LITMOD included a small monetary block that is excluded from the present model. Given the size of the model, monetary flows and the income and expenditure of the general government is also modelled at a relatively aggregated level, which is not fully adequate for evaluations of national fiscal policies.

1.1. Structure of the Model

The minimum that is needed to describe the real flows of the economy are equations determining categories of total final consumption (including import) and factor inputs by sectors. Equations explaining real flows of the economy include a number of variables such as prices and income flows that determine the real flows. Most of these variables are endogenous in the model. In addition, the model includes a number of equations describing interesting balances in current prices, e.g., the public sector deficit and the balance of payment.

A summary flow chart of LITMOD is given in Figure 1, where shaded boxes are exogenous variables. Total final demand, split into private consumption, investments, governmental consumption and export, determines domestic production and import. Production by branches is determined from demand from other branches and deliveries to categories of final consumptions using constant input-output coefficients. Domestic production determines factor demand and income. Prices are determined from production costs and the wage-determination is described by productivity and a Philips-curve relation.

Important exogenous variables to the model are the population, various taxes/tax-rates, governmental consumption, interest rate, foreign prices and demand.

¹ Arvydas Kazlauskas and August Leppä: *Two Models for the Lithuanian Economy*, SEIL project working paper, 03.10.2000.

The diagram illustrates the circular flow of income and products in a three-sector economy. It shows the interactions between various sectors and variables, including Consumption, Investments, Government consumption, Demand, Production, Employment, Unemployment, Prices, Income, Taxes, Government deficit, Wage sum, Wage rate, Labour force, Population, Governmental transfers, Indirect taxes, Tax rates, Interest rate, Profit, Export, Current account, Import, Foreign demand, and Foreign prices. Arrows indicate the flow of money and goods between these sectors and variables.

Concerning the specification of equations, an error-correction specification is generally used, implying that we estimate a long-term equilibrium equation and an adjustment mechanism. Due to few observations, a number of the parameters are restricted in estimations. In the ultimate case, long-term equilibrium parameters are determined from theoretical considerations and conventional judgments as in general equilibrium models, and adjustment parameters are estimated from observations, i.e., equations may be estimated conditioned on restrictions on long-term parameters and evaluations of reasonable adjustment parameters.

$$\Delta \log(Y) = \beta \cdot \Delta \log(Y^*) - \gamma \cdot (\log(Y_{-1}) - \log(Y_{-1}^*)) + \varepsilon \quad (1)$$

This is the general formulation we use, but we allow, in some cases, changes in the different explanatory variables (the X 's) to have different adjustment effects on changes in Y , and we include additional explanatory variables in the short-run determination of Y .

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parameters (the α 's) are interpreted as elasticities; if X_1 is increased with 1%, Y is in the long-run increased with $\alpha_1\%$.

$$\log(Y^*) = \alpha_0 + \alpha_1 \cdot \log(X_1) + \alpha_2 \cdot \log(X_2) \quad (2)$$

We assume in the estimation that the error term $\{\varepsilon_t\}_{t=1,\dots,T}$ is independent, with mean zero, and with a constant variance σ^2 . Furthermore, we assume that the error term follows a normal distribution. The last assumption is only needed when we look at test statistics after the estimation.

1.3. Structure of the Paper

The paper is structured in the following way:

Firstly, we describe the current data in Chapter 2. Secondly, we describe the different parts of the model with estimated equations and identities in Chapter 3-10. Finally, we construct a baseline scenario and show simulations with the model in Chapter 11. The list of references (p. 105) covers literature used as inspiration during the process.

2. Data

For most of the variables, quarterly data is collected for the period 1995q1 to 2002q2. A list of variables in LITMOD is included in Appendix 12.1.

The following categories cover most of the variables used in the model:

- Sectorial data (gross production, GDP, input, investment, labour);
- Government finance (expenditure, revenue, debt, budget surplus);
- Population (population, employed, labour force, unemployment rate);
- Earnings (average monthly earnings in the private and public sectors);
- Balance of payments (current account, import and export, foreign direct investment);
- Components of gross value added (taxes and subsidies on products);
- Monetary data (exchange rates, interest rates).

The time series are mainly from Statistics Lithuania and Bank of Lithuania. Statistics Lithuania also uses the data sources of other institutions such as the Ministry of Finance (government finance and taxation), Board of the State Social Security (SSSF revenue and expenditure), Labour Exchange (labour market), Ministry of Interior and Customs Department (export and import). The Bank of Lithuania supports the data on the balance of payments and monetary data. All other time series were provided by Statistics Lithuania bearing in mind pointed co-operation with other institutions.

In the following sections - documenting the different parts of the model - there will be a short description of the variables used.

In the first LITMOD, most variables were seasonally adjusted. In order to easily compare data from LITMOD with official statistics, we prefer to leave the variables unadjusted and instead

- when it is needed - use quarterly dummies in the estimations. Other arguments for not seasonally adjust the data is that it may cause auto-correlation in the time series. As stated in Greene, “the adjustment is done to smooth out unusual movements in the data and, as such, makes the current observation dependent on what was typical in the past”.²

A fundamental part of the model is the input-output system based on an input-output table from 1997. The input-output table is described in Section 2.2.1.

2.1. Aggregation Level

In LITMOD version 1, there were 5 sectors:

A	Agriculture
M	Manufacturing
C	Construction
S	Services
G	Public Service

We have chosen a more disaggregated level with the following 12 sectors. This is the same aggregation level as in the MAED model used for energy planning (LEI 2004):

A	Agriculture
MN	Mining and Quarrying
E	Energy
M1	Manufacturing in Basic Materials
M2	Manufacturing in Machinery and Equipment
M3	Manufacturing in Non-Durable Goods
M4	Manufacturing, Miscellaneous
C	Construction
S1	Trade, Hotels and Restaurants
S2	Transport, Storage and Communication
S3	Finance, Insurance, Real Estate and Business Services
S4	Community, Social and Personal Service

The energy sector (E) is oil refineries and energy conversion (electricity, heating, natural gas, and water supply). This sector and the mining sector (MN) are difficult to forecast, but are important due to expected future changes in the Lithuanian energy sector. Therefore, it is preferred to have these as separate sectors.

Also, the manufacturing sector is disaggregated into 4 sectors (M1-M4), and the service sector is disaggregated into 3 sectors (S1-S3) in order to have a more detailed forecast and facilitate analysis of structural changes.

² William Greene (1997): “Econometric Analysis”.

2.2. Input-Output Table

A central element in the model is an input-output table shown schematically in Table 1. The A-matrix gives intermediate deliveries from sector i to individual sectors. To the right of the A-matrix, we have deliveries from sectors to categories of final consumption. As in the input-output table, we have for Lithuania deliveries from sectors to intermediate – and final consumption includes deliveries of goods from similar sectors abroad. In order to obtain output (or production) by domestic sectors, import is subtracted. The matrix below the A-matrix shows payments to factor inputs and indirect taxes. Totalling columns for the sectors gives total input (also equal to output) by sectors. Totalling columns for categories of final consumption gives total private consumption, total governmental consumption, investments, export, and import. Dividing the input-output table by column sums gives input-output coefficients adding to one. We assume these coefficients to be constant.

Table 1 A Schematic Input-Output Table

From\ To	sector 1	sector 2	-	-	sector n	privat cons.	govern. cons.	investment	export	import	sum
sector 1	A-matrix					Deliveries to final consumption				Minus import	Output = production
sector 2											
-											
-											
sector n	Factor input										
wages & salaries											
gross operating surplus											
Taxes etc.											
sum											

The original Input-Output table from Bank of Lithuania has 28 sectors and 4 components of final consumption (private consumption, public consumption, investment, and export). The data is from 1997 and in basis prices.

2.2.1. Calculation of Input-Output Coefficients

We have in the Input-Output table rows with deliveries of total supply (import and domestic production) to sectors and to final consumption. The supply of type j (j is index for the 12 sectors: A, MN, E, M1, M2, M3, M4, C, S1, S2, S3, S4) consists of domestic production in sector j (Q_j) and import from similar sectors abroad (M_j). The supply is delivered to other sectors i and to the categories of final consumption (X_k) and equals the total use of type j . We have four components of final consumption (private consumption, public consumption, investments, and export).

In (3), the a 's are input-output coefficients calculated as the corresponding table entries in the input-output table divided by the column sum. For example, $a_{A,M3} \cdot Q_{M3}$ is agricultural products

(A) delivered to food manufacturing (M3), and $a_{A,C} \cdot C$ is agricultural products (A) delivered to private consumption (C).³

$$Supply_j = M_j + Q_j = \sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k = Use_j \quad (3)$$

In the model, we use these relations to determine domestic production in the 12 sectors (Q_j). The input-output coefficients are calculated from the total supply including import, and we calculate domestic production from the input-output deliveries by subtracting the import, as seen in equation (4). The modelling of domestic production is described in detail in Section 8.1.

$$Q_j = \sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k - M_j \quad (4)$$

However, we do not have time series of import of 12 types (the M_j 's), but only total import of goods (M). Therefore, we assume that the composition of the import is constant (e.g., the amount of imported agricultural products is a constant proportion of the total import), i.e, we have:

$$Q_j = \sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k - m_j \cdot M \quad (5)$$

The coefficients m_j are assumed constant and calculated as M_j/M . The import coefficients fulfil the restrictions $\sum_j m_j = 1$.

The Input-Output table includes a row with Primary Energy Input. This is import, only (no domestic production), and most of it is used in the sectors (not as final consumption). In the Input-Output table, the sum “Total Intermediate” differs from “Intermediate Official” with the exact supply of Primary Energy Input. For all other goods and services, import and domestic production are columns, and the total supply is divided into the different deliveries. Therefore, we have chosen to add the row Primary Energy Items to the column with import and subtract it from the column with production.

The Input-Output matrix aggregated to 12 sectors and the matrix with the calculated Input-Output coefficients is included as Table 28 and Table 29 in Appendix 12.2.

The Input-Output coefficients are calculated with yearly data from 1997, and we assume in the model that these coefficients are constant. In a forecast, the user is able to change the value of the coefficients due to specific knowledge about the sectors, but the user has to make sure that the restrictions on the coefficients are not violated.

Table 2 shows that the service sectors (S1-S4) have 47% of the total domestic production in 1997 whereas the public sector (S4) alone accounts for 14%. Manufacturing accounts for 27% of total domestic production, and the M3-sector (manufacturing of non-durable goods) is the largest sector with 18% of total domestic production.

³ There is in an Input-Output table often a row (or more) with import deliveries to sectors and final consumption. In the above example, this means that it would have been possible to divide the delivery of agricultural products to private consumption into deliveries from domestic production and from import.

Table 2 Size of Sectors as Share of Total Domestic Production in 1997

Sector	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
Output												
Share in %	12	1	7	4	4	18	1	8	15	9	7	14

The five largest deliveries to sectors (more than 1 bill. Litas in 1997) are deliveries of agricultural products (imported and domestically produced) to sector M3 (manufacturing of non-durable goods, including foods), deliveries from S1 (trade, etc.) to A (agriculture) and M3 (manufacturing of non-durable goods), deliveries from S3 (finance, insurance, renting, business service, etc.) to S4 (public sector) and deliveries from M1 (manufacturing in basic materials including building materials) to sector C (construction).

Table 3 shows the I-O coefficients for deliveries from sectors to the components of final consumption. The final consumption components are C_p private consumption (demand described in Section 3.3), C_g public consumption (Section 4.1), I investments (Section 5.2), and X export (Section 6).⁴

Table 3 I-O Coefficients for Deliveries from Sectors to Final Consumption

Sector	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
$a_{j,Cp}$	0.13	0.00	0.07	0.03	0.04	0.45	0.03	0.02	0.14	0.03	0.00	0.05
$a_{j,Cg}$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
$a_{j,I}$	0.00	0.00	0.00	0.08	0.34	0.02	0.00	0.33	0.03	0.14	0.05	0.01
$a_{j,X}$	0.11	0.00	0.12	0.16	0.11	0.23	0.02	0.02	0.11	0.10	0.02	0.00

If we look at the composition of the private consumption (C_p), 13% is delivered from agriculture (food), 7% is energy use, 55% is goods, and 36% is services. All public consumption (C_g) is delivered from the public service sector (S4).

The investments from sectors and households (I) are buildings (delivered from sector C) and machinery (sector M2). Manufacturing accounts for 52% of the export, service sectors for 23%, agricultural products is 11% of the export, and energy products is 12% of the total export.

3. Households

We begin this section by going through some theories on private consumption in 3.1. In 3.2, we discuss how to construct a variable for disposable income. Afterwards, we estimate an equation for private consumption in 3.3 and an equation for household investment in dwellings in 3.4.

3.1. Private Consumption, Theory

The determination of total private consumption is a crucial variable in macro-economic models and the specification of this relation has been the subject of numerous studies. In all studies, the fundamental link is that private consumption will in the long run depend on some

⁴ The table is transposed from the table in the Appendix.

income or wealth measure, but the specification of the link varies between studies. In the short run, several other variables may be included:

- Changes in the unemployment rate as a proxy for uncertainties with respect to future income;
- Consumer prices or inflation - increased inflation will in the medium-term dampen consumption due to efforts to keep real savings unchanged;
- Changes in real interest rates; changes income from capital/savings and is a proxy for capital gains/loses;
- Changes in the composition of income - the propensity to consume out of wage, profit income or social transfers are not necessarily identical.

One way to specify the link between consumption and income/wealth is that total private consumption is a constant share of some income measure. Thus

$$C_t = a_0 \cdot Y_t^* \quad (6)$$

where C_t is total private consumption in period t , Y_t^* is income in period t , and a_0 is the constant share of income that is consumed.

Taking logarithms of (6), we have

$$\log(C_t) = \alpha_0 + \log(Y_t^*) \quad (7)$$

If we assume that the marginal propensity to consume differs from unity, (7) may include a constant to the income term, i.e.,

$$\log(C_t) = \alpha_0 + \alpha_1 \cdot \log(Y_t^*) \quad (8)$$

where α_1 is the marginal propensity to consume. This is the standard Keynesian formulation of private consumption using current disposable income as Y_t^* .

The Modigliani life cycle theory of consumption states that the consumers prefer to smooth consumption over lifetime, so consumption depends not only on current income, but is subject to an intertemporal budget constraint. The Friedman permanent income hypothesis states that transitory changes in income mainly lead to temporary changes in consumption, whereas current consumption will depend on the consumers' permanent income, i.e., their expected long-run average income.

The permanent income level is somehow related to the present and previous income. One way to calculate the permanent income is to assume this to be a geometric average of present and previous incomes, i.e.,

$$\log(Y_t^*) = (1 - \lambda) \sum_{i=0}^{\infty} \lambda^i \cdot \log(Y_{t-i}) \quad (9)$$

Inserting this into (8), we have

$$\log(C_t) = \alpha_0 + \alpha_1(1-\lambda) \sum_{i=0}^{\infty} \lambda^i \cdot \log(Y_{t-i}) \quad (10)$$

Now, subtracting $\lambda \cdot \log(C_{t-1})$ from (10), we have (11) that may be estimated,

$$\log(C_t) = (1-\lambda)\alpha_0 + (1-\lambda)\alpha_1 \log(Y_t) + \lambda \log(C_{t-1}) \quad (11)$$

Normally, C_t and Y_t , the real private consumption and real disposable income, are defined per capita. In addition, to cope with short-term changes, a number of proxy variables for the effects mentioned in the bullet points may be included. For instance, including changes in the unemployment rate to mirror uncertainties with respect to future income in (10), changes (11) to

$$\log(C_t) = (1-\lambda)\alpha_0 + (1-\lambda)\alpha_1 \log(Y_t) + \alpha_2(\Delta U_t - \lambda \cdot \Delta U_{t-1}) + \lambda \log(C_{t-1}) \quad (12)$$

where ΔU_t is the change in the unemployment rate from period $t-1$ to t .

Looking at private consumption in a slightly different way, consumers may during their lifetime tend to optimise utility depending on consumption and the wealth they leave. When simplifying assumptions, optimisation of budget restrictions implies that the aggregated consumption function may be written as a linear homogenous function in income and capital. Using logarithmic transformations, we may write the long-term consumption function as

$$\log(C_t^*) = \beta_0 + \beta_1(\theta \cdot \log(Y_t) + (1-\theta) \cdot \log(W_t)) \quad (13)$$

The parameter β_1 is the marginal propensity to consume, and if we assume a constant share of income and capital used for consumption, β_1 is restricted to 1. If we have no data for capital, θ is implicitly restricted to 1, implying that only current income affects consumption.

Modelling the adjustment to the long-run relation by an error correction model, including variables describing short-term variations in consumption, we have

$$\text{Dlog}(C_t) = b_1 \cdot \text{Dlog}(Y_t) + b_2 \cdot \text{Dlog}(X_t) - \gamma[\log(C_{t-1}) - \log(C_{t-1}^*)] \quad (14)$$

where X represents additional short-term explanatory variables, and b_1 is the short-run marginal propensity to consume out of current income.

Under certain restrictions, the two approaches give the same equation. First of all, (11) can be rewritten as

$$\text{Dlog}(C_t) = (1-\lambda)\alpha_0 + (1-\lambda)\alpha_1 \log(Y_t) - (1-\lambda)\log(C_{t-1}) \quad (15)$$

Since we have no data for household capital in the model, the parameter θ is restricted to one in (13) and the equation states that

$$\log(C_t^*) = \beta_0 + \beta_1 \cdot \log(Y_t) \quad (16)$$

The error correction towards this long run optimal consumption level can be rewritten (here without additional explanatory variables) as

$$\begin{aligned}
\text{Dlog}(C_t) &= b_1 \text{Dlog}(Y_t) - \gamma [\log(C_{t-1}) - \log(C_{t-1}^*)] \\
&= b_1 \text{Dlog}(Y_t) - \gamma \log(C_{t-1}) + \gamma \beta_0 + \gamma \beta_1 \log(Y_{t-1}) \\
&= \gamma \beta_0 + b_1 \log(Y_t) - \gamma \log(C_{t-1}) + (\gamma \beta_1 - b_1) \log(Y_{t-1})
\end{aligned} \tag{17}$$

This equals (15) if, and only if, $b_1 = \gamma \cdot \beta_1$ (with $\alpha_0 = \beta_0$, $\alpha_1 = \beta_1$, and $\gamma = 1 - \lambda$), i.e., we estimate one additional parameter in the second approach instead of assuming that the short-run marginal propensity to consume (b_1) is given by the long-run marginal propensity to consume (β_1) and the adjustment speed (γ).

3.2. Disposable Income

The disposable income is an important variable in macroeconomic models and in LITMOD. Disposable income is the main explanatory variable for the development of private consumption. At present, its definition is not a trivial task and we try in this section to explain why.

Lithuanian Statistics defines disposable income as the sum of the following income flows: total income in cash and kind⁵ received as earnings from employment, income from farming, business, handicrafts and free professional activity as well as pensions, benefits, scholarships, income from property, and rent. However, we do not have “official” data on a reasonable disposable income. Alternatively, we construct an instrumental variable (18), which we call “disposable income”. This variable consists of three main parts: after-tax income from employment, net profit from business and farming activities and payments from State Social Security Fund (SSSF).

$$\begin{aligned}
Y_t &= 0.001 \cdot 3 \cdot \left((nt_{\min} + (w_{PRI} - nt_{\min}) \cdot (1 - t_L)) \cdot L_{PRI} + (nt_{\min} + (w_{PUB} - nt_{\min}) \cdot (1 - t_L)) \cdot L_{PUB} \right) \\
&\quad + Prof \cdot (1 - t_C \cdot tcbase) + 0.001 \cdot 0.96 \cdot C_{GSS}
\end{aligned} \tag{18}$$

Where,

Y_t	Disposable income (DI , mill. Litas current prices)
L_{PRI}	Labour demand in the private sector ($LNpri$, 1000 fulltime workers)
L_{PUB}	Labour demand in the public sector ($LNS4$, 1000 fulltime workers)
w_{PRI}	Average monthly gross earning in private sector ($Wpri$, Litas current prices)
w_{PUB}	Average monthly gross earning in public sector ($Wpub$, Litas current prices)
nt_{\min}	Non-taxable monthly wage ($ntmin$, Litas current prices)
$Prof$	Profit from firms ($PROF$, mill. Litas current prices)
C_{GSS}	Expenditure of SSSF ($CGSEV$, 1000 Litas current prices)
t_L	Consolidated tax on labour
$t_C \cdot tcbase$	Consolidated tax on profits

⁵ Due to the nature of these non-cash earnings, it is difficult to estimate its level and we should consider it as additional benefits from employment and income from non-business activities: income in kind from hunting, fishing, gathering mushrooms, berries, etc.

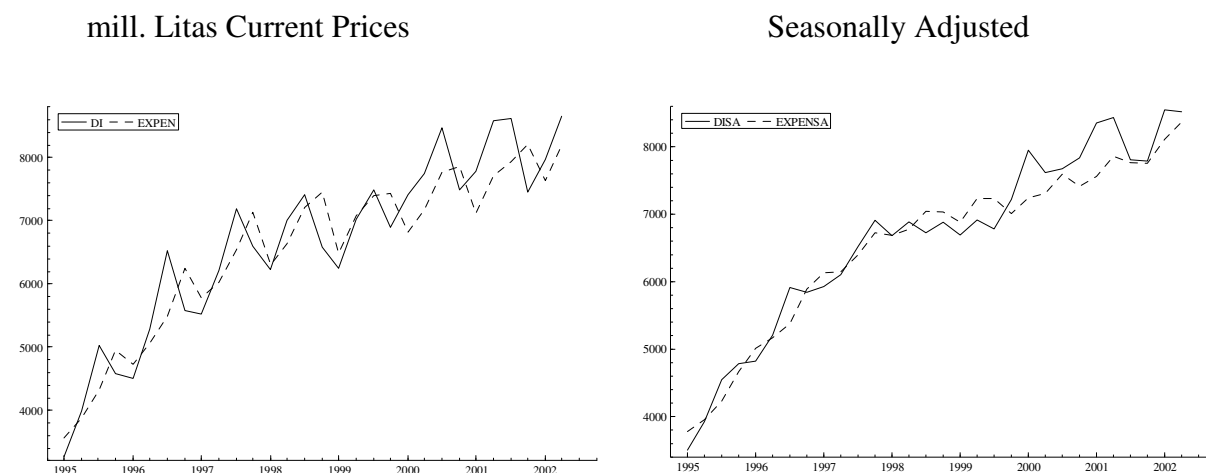
In (18), different income flows are converted from monthly data to quarterly data and time series in thousands of Litass into millions of Litass.

There are two average constructed tax rates in (18). Most of the employees pay 33% labour tax from the wage sum subtracted by minimum non-taxable monthly wage (214 Lt. before 01.01.2002, 290 Lt., after 01.01.2003 and 250 Lt. in-between) and 3% tax to the social security fund. In addition, 15% labour tax is levied on seamen's income, income from sporting, artistic activities, royalties, etc. Besides this, a number of employees pay a fixed tax into the national budget. We have over the estimation period exercised different combinations of the mentioned tax concluding that the consolidated tax rate on income is 25-30%. It is assumed in the model that the income tax rate (t_L) is equal to 27%. Concerning taxes on profit, an appropriate assumption for the level of the tax rate (t_C) is 22% and a correction factor ($tcbase$) of 0.188, which is an average tax rate on profit of 4.1%.

Finally, we assume that all SSSF expenditure, except for administrative costs (4%), is transferred into household disposable income.

Figure 2 illustrates that the estimated disposable income is very close to the amount of private consumption and investments in dwellings. It even exceeds this expenditure over the last two years. It is seen from the graph that disposable income reaches maximum during the second and third quarter of the year, while consumption increases during the year (and then decreases in the beginning of the next year).

Figure 2 Disposable Income (Y_d) and Expenditure ($C_p + I_h$)



3.3. Private Consumption

According to the Lithuanian Statistical Yearbook, *consumption expenditure* includes expenditure in cash and kind for household consumption needs, i.e., food, clothes, footwear, dwelling, health care, culture, and recreation. Consumption expenditure is grouped by the COICOP classification (Classification of Individual Consumption by Purpose prepared by OECD). However, at present, we look at relations in the model between aggregated private consumption and disposable income. At a later stage, the structure of private consumption may be modelled by a consumer demand system.

We use the second approach from Section 3.1 to model private consumption in the model. Since we have no data for the household capital, we use the formulation in (16) as the long-run consumption function. Quarterly dummies are added to allow for seasonal differences in income and consumption.

$$\log(Cp^*) = \alpha_0 + \alpha_1 \cdot \log(Y/P_C) + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (19)$$

The adjustment to the long-run relation is an error correction model, and the short-run marginal propensity to consume (β_1) is allowed to differ from the long-run propensity (α_1). Consumption in the short-run allowed to depend on changes in consumption price (P_C), changes in interest rate (i), and changes in the unemployment rate (U).⁶

$$\begin{aligned} \text{Dlog}(Cp) = & \beta_1 \text{Dlog}(Y/P_C) + \beta_2 \text{D}(i) + \beta_3 \text{D}(U) + \beta_4 \text{Dlog}(P_C) \\ & + \beta_0 [\log(Cp_{-1}^*) - \log(Cp_{-1})] \end{aligned} \quad (20)$$

Where

Cp	Private consumption (CRN , mill. Litas constant prices)
Cp^*	Private consumption, equilibrium level
Y	Disposal income in household sector (DI , mill. Litas current prices)
P_C	Price deflator on private consumption (pc , 1995=1)
i	Interest rate (ra is average annual interest rate in %)
U	Unemployment rate (U , rate)
Q_2 - Q_4	Quarterly dummies; Q_2 is equal to one in second quarters and else zero.

In Appendix 12.3, we show three different estimations of equation (19) and (20), describing private consumption almost identically, but with very different results when used in the model. This demonstrates some of the considerations we have before choosing an estimation to use in the model – not just in this case, but with all the equations.

As explained in the Appendix, we choose to estimate the long-run marginal propensity to consume (α_1) in the long-term equation (19) and then estimate the dynamic adjustment (20) with this parameter fixed. Parameter estimates and t-statistics as well as R^2 are shown in Table 4.

Table 4 Parameter Estimates, Private Consumption

Param	α_0	α_1	λ_2	λ_3	λ_4	β_0	β_1	β_2	β_3	β_4
	1.726	0.806	-0.012	0.069	-0.268	0.351	0.232	-0.010	0	-0.666
	[40.20]	* ¹	[-0.36]	[1.07]	[2.68]	[2.97]	[2.68]	[-2.58]	*	[-3.55]
Estimation period 1995q2-2002q2. t-values in []. $R^2 = 0.949805$										
* Restricted parameter. ¹ t-value in estimation of long-run equation is 12.94.										

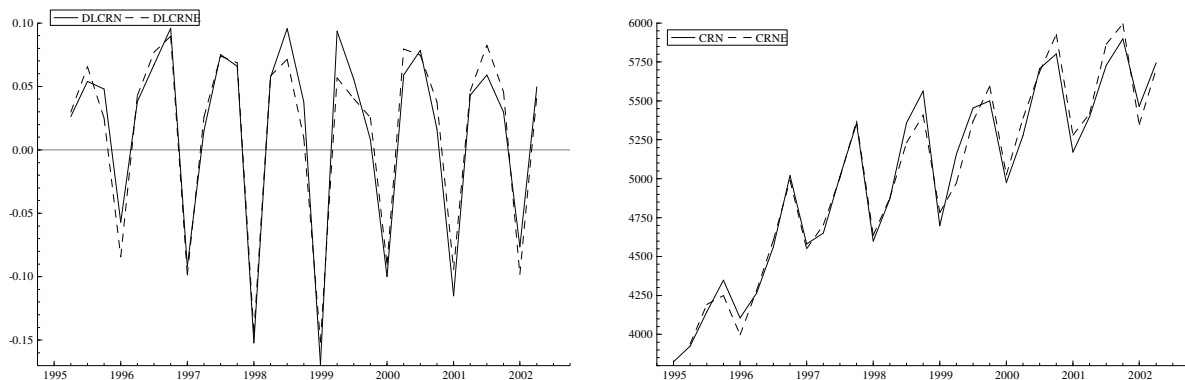
⁶ Instead of changes in the logs of unemployment rate and interest rate, we use the changes (i.e., $D(U_t) = U_t - U_{t-1}$) since the variables are in %. Then, the parameter measures how many % consumption will change if the unemployment rate is changed by 1% point.

The marginal propensity to consume is 23% in the short-run (β_1) and 81% in the long-run (α_1). There was no significant effect of changes in the unemployment rate ($\beta_3 = 0$). Increased interest rate decreases consumption moderately in the short-run (an increase in the interest rate of 1 percentage point decreases the private consumption with 1% ($\beta_2 = 0.01$) in the first quarter, but the private consumption remains unchanged in the long-run); money deposit is more valuable now so consumption is pending until later. Additionally, it is important to mention that the whole system adapts rather quickly to the equilibrium state ($\beta_0 = 0.35$).

The quarterly dummies are included in the long-term equation.⁷ We can see that if we should have the simple long-term equilibrium relationship between consumption and disposable income, then consumption should be lower in the fourth quarter ($\lambda_4 < 0$). As mentioned in Section 3.2, disposable income is highest in the second and third quarter while consumption reaches the yearly maximum in the fourth quarter.

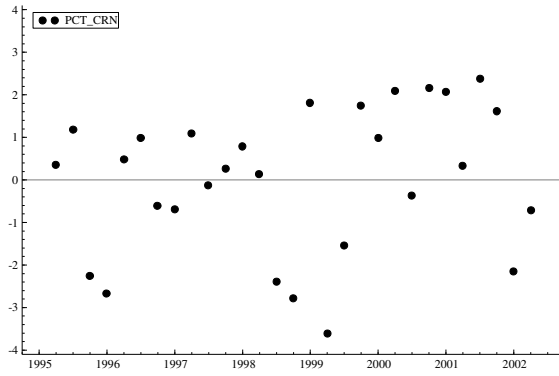
To illustrate the estimation, Figure 3 shows the actual value and the estimated value of private consumption. The left graph shows the fitting of the growth rate where the straight line DLCRN is the actual value of $D\log(C)$ and the dotted line with label E is the estimated value. The right graph shows the actual and estimated level of private consumption. The residuals from the estimations are less than 4% as seen in Figure 4.

Figure 3 Private Consumption: Actual and Estimated Values in Growth Rate (left) and Level (right)



⁷ The three quarterly dummies are included in the estimation if one or more of the dummies improve the explanation (increases the adjusted R^2); as a rule of thumb, this is the case if the numerical t-value is above 1.

Figure 4 Private Consumption, Residuals in %



3.4. Household Investments in Dwellings

Investments in dwellings are, compared with private consumption, approximately 2.5%. This is a relatively small part, but investment in dwellings is an important macro-economic indicator. Increasing investments are caused either by increased real income or improved financial intermediation (more loans and credits to households). On the other hand, economical depressions caused by internal and/or external factors (e.g., Russian crisis, high inflation rate, EU entrance, etc.) will immediately influence the dynamics of household investments in dwellings.

The most important determinants for investments in dwellings are the real disposable income, producer price on construction, long-term loans on dwellings or interest rate on these loans. The “external” factors mentioned above are included in the model in the form of dummies. For example, Figure 5 (left) shows an increase each 4th quarter in investments excluding the two-year period of the Russian crisis. Therefore, the model includes a modified dummy for the 4th quarter as well as a dummy for the relatively rapid decrease in 1998q2. The long-run relationship is specified as (21).⁸

$$\log(I_H) = \alpha_0 + \alpha_1 \log(Y_{-1} / P_{C,-1}) + \alpha_2 \log(P_{Q_C}) + \alpha_3 i + \alpha_4 D98q2 + \lambda_4 Q_{4IH} \quad (21)$$

Where

I_H	Investments in dwellings (IRH , mill Litass constant prices)
Y	Disposable income (DI , mill Litass current prices)
P_C	Consumer price index (pc , 1995=1)
P_{Q_C}	Producer price in construction sector (pqc , 1995=1)
i	Interest rate (ra is average annual interest rate in %)
$D98q2$	Dummy (1 in 1998q2, else 0)
Q_{4IH}	Modified quarterly dummy for 4 th quarter

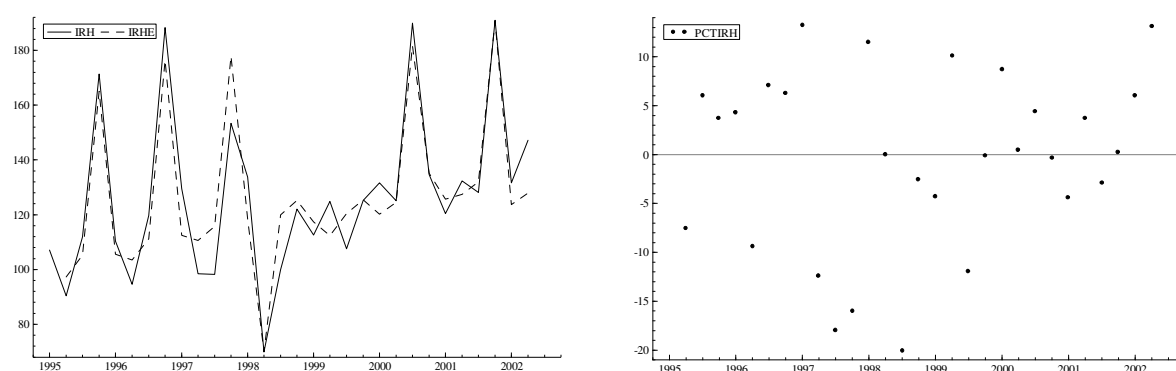
⁸ We only have data for investments in dwellings in current prices (IVH) and calculate investments in constant prices using the overall investment deflator ($pi = IV/IRN$).

Estimated parameters and t-statistics are shown in Table 5, and the fit of the equation is shown in Figure 5. We could not estimate a significant effect of price on construction or interest rate (α_2 and α_3 are restricted to zero). When real disposable income increases, households invest more in dwellings. However, the income elasticity is below one ($\alpha_1 = 0.56$).

Table 5 Investments in Dwellings, Parameter Estimates

Parameter	α_0	α_1	α_2	α_3	α_4	λ_4
	0	0.561	0	0	-0.479	0.350
	*	[245.41]	*	*	[-5.03]	[7.60]
Estimation period 1995q1-2002q2; t-values in [];* restricted parameter; R^2 0.845565						

Figure 5 Household Investments in Dwellings, Fit and Residuals



4. Governmental Finance

In any economic model, the description of the governmental finance is very important, as governmental consumption is a large part of final demand and because the financing of governmental consumption has considerable implications for the economical development. The Government primarily maintains the following two functions:

- The provision of public goods and services to households and companies;⁹
- Redistribution of income and wealth.

The financial resources accumulated in the Lithuanian state budget are used to finance general public needs. Together with municipal budgets, the state budget forms the national budget, the management of which is based on the laws of the Republic of Lithuania.

The Government affects the economy mainly through governmental expenditures, taxation, regulation, and publically owned enterprises. These aspects of governmental influence are briefly discussed in the sections below.

⁹ Examples of public goods and services are national defence, law enforcement, public health, transportation, and education.

We should also pay attention to methodological difficulties. Up to the present year, the Ministry of Finance used a quite old methodology presented in the IMF Government Finance Statistics Manual 1986 (GFSM 1986) for the calculations of general government finance. Today, the Ministry uses the ESA'95 methodology harmonised with the new IMF GFSM 2001. As the two methodologies are incomparable, one should be careful when the model is updated with new data on public finance.

Additionally, this chapter covers equations for the State Social Security Fund budget in Section 4.3. The social insurance system in Lithuania comprises social insurance contributions (compulsory and voluntary) paid by the employer and social insurance benefits.

4.1. Government Consumption

The Government consumption, C_g , is one of the final demand components in the input-output system. All the demand for government consumption is delivered from the public sector (S_4).

As mentioned above, the state and municipal budgets make up the national budget, and is used for education, culture, science, health care, social welfare, environmental protection, economy development, general government and national defence.

The Government's consumption in Lithuania consists of three main parts: expenditures on economy (infrastructure, housing, agriculture, forestry, manufacture, fuel and energy, etc.), social issues (health and education, social care and recreation) and other government expenditures (army, police, general government services, etc.). The last two parts are joined into current expenditures; the first forms the capital expenditure, which varies from 7% to 17% of the total government budget.

We assume in the model that the governmental consumption is exogenous – a very important policy variable.

4.2. Government Revenue and Balance

First of all, we would like to investigate the general structure of government revenue.

Budget revenue consists legally of taxes and other receipts established by the laws of the Republic of Lithuania. According to the GFSM 1986, government revenue is divided into two parts: taxes and other revenue.

In the model, the governmental revenue (R) consists of four parts: tax on wage income (R_w), tax on profit (R_p), revenue from VAT paid by households (R_v), and taxes minus subsidies paid by the production sectors (R_s).

$$R = 1000 \cdot (R_w + R_p + R_v + R_s) \quad (22)$$

The calculation of the four revenues in the model is shown in (23).

$$\begin{aligned}
R_w &= 0.001 \cdot 3 \cdot ((w_{PRI} - nt_{min}) \cdot t_L \cdot L_{PRI} + (w_{PUB} - nt_{min}) \cdot t_L \cdot L_{PUB}) \\
R_p &= Prof \cdot t_C \cdot tcbase \\
R_v &= C \cdot P_C \cdot t_{vat} / (1 + t_{vat}) \\
R_s &= t_p \cdot C_T
\end{aligned} \tag{23}$$

Where

R	Governmental revenue ($CGREV$, 1000 Litas current prices)
R_w	Revenue from tax on wage ($CGRE VW$, mill. Litas current prices)
R_p	Revenue from tax on profit ($CGRE VP$, mill. Litas current prices)
R_v	Revenue from VAT paid by households ($CGRE VV$, mill. Litas current prices)
R_s	Revenue from net taxes paid by sectors ($CGRE VS$, mill. Litas current prices)
L_{PRI}	Labour demand in private sector ($LNpri$, 1000 full time workers)
L_{PUB}	Labour demand in public sector ($LNS4$, 1000 full time workers)
w_{PRI}	Average monthly gross earning in private sector ($Wpri$, Litas current prices)
w_{PUB}	Average monthly gross earning in public sector ($Wpub$, Litas current prices)
nt_{min}	Non-taxable monthly wage ($ntmin$, Litas current prices)
$Prof$	Profit from firms ($PROF$, mill. Litas current prices)
t_L	Consolidated tax on labour (tl)
$t_C \cdot tcbase$	Consolidated tax on profits (tc , $tcbase$)
C	Private consumption (CRN , mill. Litas constant prices)
P_C	Price on private consumption (pc , 1995=1)
t_{vat}	VAT rate (vat)
t_p	Net tax rate on products (tp)
C_T	Inputs in sectors ($INVT$, mill. Litas current prices)

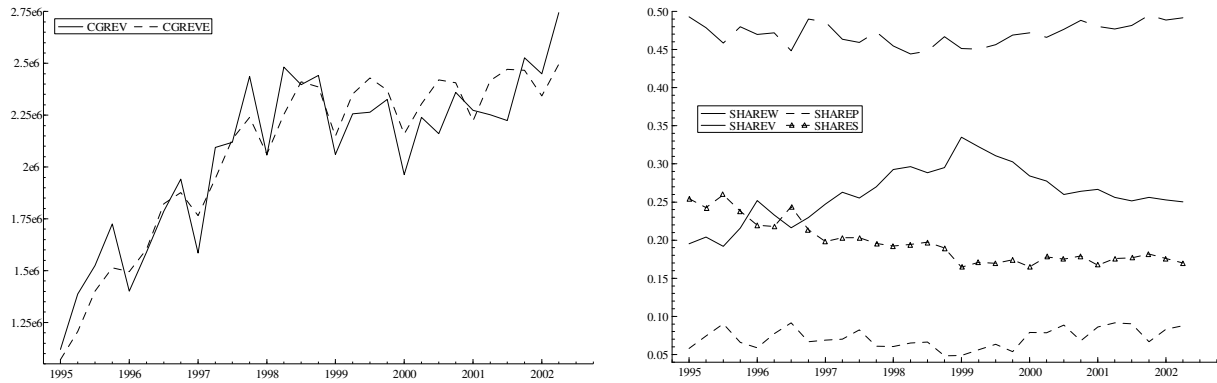
There is a taxation of two types of income, namely wage and profit. Tax on wage income is discussed in Section 3.2 and, in the model, we use a constant tax rate on wage income ($t_L = 0.27$) in the estimation period. As tax rate on profit from sectors, we use the tax rate on capital income ($t_C = 0.22$). However, this generates larger revenue than the officially published data. Therefore, we use a correction factor ($tcbase = 0.188$) correcting for income levels as done in Leppä's version of LITMOD.

The second part of government revenue is taxes on products and other revenue. First of all, households pay VAT on goods and services. In the model, we use an average VAT rate of 18% ($t_{vat} = 0.18$). The revenue is close to the official VAT revenue. The VAT base is private consumption in current prices ($C \cdot P_C$). As this includes VAT, we correct for this by multiplying by $1/(1+t_{vat})$. The remaining part of the revenue is assumed in the model to be paid by the production sectors. We use a calculated average net tax rate in the model on products of 4.5% ($t_p = 0.045$).¹⁰

¹⁰ The rate is calculated from the official revenue from taxes on products and other non-product taxes minus subsidies minus the calculated revenue from VAT paid by households.

Figure 6 (left) shows that the calculated level of government revenue ($C_{grev}E$) is close to the official government revenue (C_{grev}). From the structural analysis of government revenue, it is seen that ((23) and Figure 6 (right)) approximately 47% of the revenue derives from VAT. Taxes on labour income contribute 26%; the rest is obtained from other taxes on products and taxes on profits. The smallest share comes from taxes on profits, i.e., the largest part of profits goes into disposable income of households and indirectly joins the national budget through private consumption and VAT. Within a black market economy, VAT has the advantage of tax consumption and not income in order to collect desirable tax revenue.

Figure 6 Government Revenue, Fit and Structure



The governmental balance (deficit) is defined as government expenditure¹¹ subtracted by government revenue.

$$G_{DEF} = R - 1000 \cdot C_g \cdot P_{C_g} \quad (24)$$

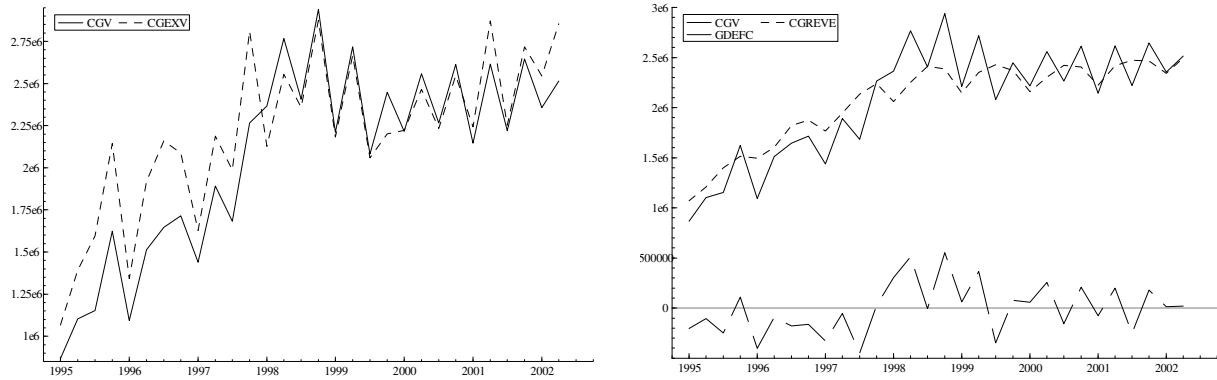
Where

- G_{DEF} government deficit ($GDEF$, 1000 Litass current prices)
- C_g government consumption, national accounts ($CGRN$, mill. Litass constant prices)
- P_{C_g} price index on government consumption (pcg , 1995=1)
- R government revenue ($CGREV$, 1000 Litass current prices)

As seen in Figure 7 (right), the estimated revenue is higher than real expenditure, mostly at the beginning of the estimation period. This is the part where CGV mostly differs from $CGEXV$, but as the $CGEXV$ and estimated government revenue are getting closer to $CGEXV$ and $CGREV$, respectively, the difference between estimated and real government deficit becomes smaller. This convergence allows us to include (24) into the model. This inclusion is very useful when analysing scenarios. It is important to consider whether or not the government deficit is constantly increasing.

¹¹ There are two different sources for data on government expenditure: the part from GDP calculated by expenditure approach on the basis of national accounts (CGV), another from the Ministry of Finance as discussed above ($CGEXV$). The principles of their calculus are very close, so the theory showed above also works in the case of CGV . Though CGV is a bit lower, we prefer to use CGV in the model as it does not include non-budgetary funds and some other parts of national budget.

Figure 7 Governmental Expenditure (left) and Governmental Balance (right)



4.3. Social Security Fund

The State Social Insurance system covers nearly all Lithuanian residents: either as the insurers, the insured, or the beneficiaries. The system is based on the principle of solidarity of generations: employed population support pensioners, disabled and unemployed persons by paying social insurance contributions.

The employer (the sectors) pays a fixed rate of the wage payments to the Social Security Fund (34%), and the revenue of social security fund is, therefore, calculated as a share of total domestic wages:

$$R_{SSF} = t_{ssf} \cdot W \quad (25)$$

Where

R_{SSF} Revenue of SSF ($SSCIN$, mill. Litas current prices)

t_{ssf} SSF rate (ssc)

W Wage sum ($Wsum$, mill. Litas current prices)

The social fund expenditure is paid to households ($CGSEV$ is included in the disposal income DI , see Section 3.2). Figure 8 (left) shows that expenditure is since 1998 much greater than revenue. However, according to the latest report from the SSSF, the deficit decreased and became minimal.

State Social Security Fund expenditure structurally consists of the following parts:

$$C_{GSS} = Pension + Health + Benefits + Unem + FC + Other \quad (26)$$

Where

C_{GSS} Expenditure of SSSF ($CGSEV$, 1000 Litas current prices);

Pension Retirement benefits, disability pensions, deferred pay

Health Sickness benefit

Benefits *Special benefits*: child benefit, widowhood benefit and scientist benefit

Unem Unemployment compensation

<i>FC</i>	Fixed cost (administration, wages, etc.)
<i>Other</i>	Other expenditures

According to statistical information for the period 1995 to 2001, an average of 72.4% was spent on pensions, 9.3% on special benefits, and 9% on health insurance; 4% was fixed cost, unemployment compensations and other benefits took the remainder of approximately 5%. In the calculation of disposable income of households, we should pay attention to the estimated fixed cost. In the identity for household disposable income CGSEV is included, using a 0.96 correction factor.

We should notice that retirement benefit is the largest part of SSSF's expenditure. In the model, we included exogenous variables for the number of pensioners and for the other part of SSSF's expenditure. It is intuitively clear that the wage-rate is an import determinant for pensions and possibly for the other expenditure, i.e., we specify the following equation for an average monthly pension:

$$\log(Pens) = \alpha_0 + \alpha_1 \log(P_C) + \alpha_2 \log(W_{PRI}) + \lambda_2 Q_2 + \lambda_3 Q_3 + \lambda_4 Q_4 \quad (27)$$

Where

<i>Pens</i>	Average pension (monthly in Litas)
<i>P_C</i>	Consumer price index
<i>W_{PRI}</i>	Average wage in private sector (monthly in Litas)
<i>Q₂ – Q₄</i>	Quarter dummies

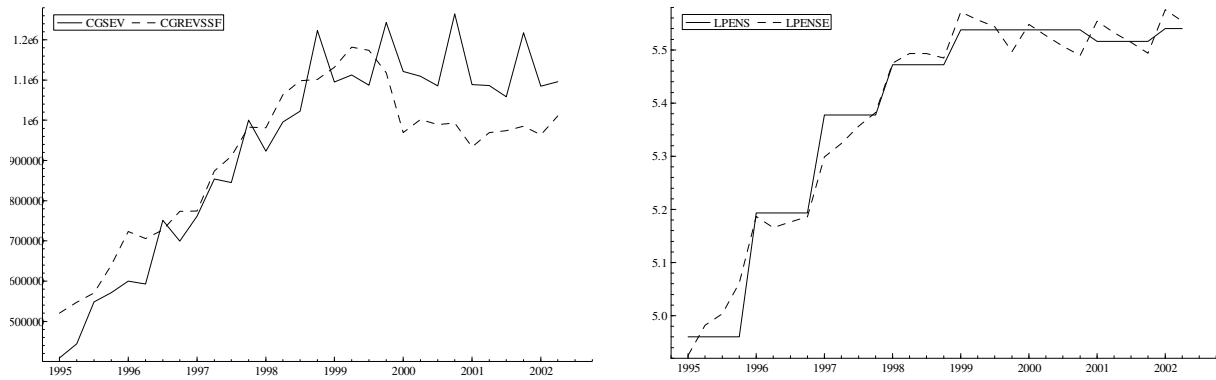
Table 6 Monthly Pension, Parameter Estimates

Parameter	α_0	α_1	α_2	λ_2	λ_3	λ_4
	.640576	0	.703500	-.038229	-.053483	-.091575
	[3.82758]	*	[28.4816]	[-2.01378]	[-2.72407]	[-4.63528]
Estimation period 1995q1-2001q4; t-values in []; *restricted parameter; R ² = 0.970						

We see that the value of pension is positively related to the average monthly wage, but the elasticity is below one. This implies that pensions do not keep up with changes in average wage within the private sector. There was unfortunately no significant influence of the consumer prices (parameter restricted to zero). The final equation for SSSF expenditure is specified as:

$$C_{GSS} = 3 \cdot Pens \cdot Pensnr + C_{GSS,other} \quad (28)$$

Figure 8 SSF Revenue and Expenditure (left). Pension (right)



5. Investments

The gross domestic investment (*IRNI* in our notation) is a very important part of GDP. Its dynamics represent the country's ability to satisfy the population's increasing need for goods and services. The creation and accumulation of capital is intended to increase the level of productivity and thus allow for an increase in the production of goods and services at a future date.

Traditionally, economists distinguish between capital, non-capital and financial (portfolio) investments. This model primarily concentrates on capital investments and partly investigates financial investments since foreign direct investments (FDI)¹² are used as one of the determinant of gross investment. Besides capital investment, gross domestic investments also include the value of investment in non-capital assets (information, human capital, technology, etc.) not directly measured within this model, but not less important.

According to the Statistical Yearbook, the capital investment could be defined as the investment in tangible fixed assets covering cost of buildings, equipment, machinery, vehicles, construction and alteration of existing fixed assets (current maintenance costs are excluded). Total capital investment consists of capital investments in sectors (I_j) and household investments in dwellings (I_H):

$$I_C = \sum_j I_j + I_H \quad (29)$$

Foreign direct investment could be characterised as investment forming the basis for long-term relations between a direct foreign investor and an enterprise of direct investment. 10% of votes are considered to be the lowest level, allowing a direct foreign investor to participate in the management of a direct investment enterprise. Foreign investment that allows less than 10% of votes is defined as portfolio investment and not as direct investment.

In summarising the discussion, we define gross domestic investments as:

¹² In fact, there are two ways to calculate the foreign direct investments: from the stock of foreign direct investments and from the balance of payment. However, the Bank of Lithuania and Statistical Department use different bond prices (nominal and market) approaches for these calculations, so that the data becomes incomparable. It could even bring a paradoxical situation when *fdi* is growing by one approach and decreases by another. In our work, we use data from the balance of payment. We use *fdi* as an exogenous variable.

$$I_D = I_C + I_f + I_{nc} \quad (30)$$

Where

I_D Gross domestic investments (*IRNI*, mill. Litas constant prices)

I_C Total capital investments (*IRTH*)

I_f Investments in financial assets (portfolio investments)

I_{nc} Non-capital investments¹³

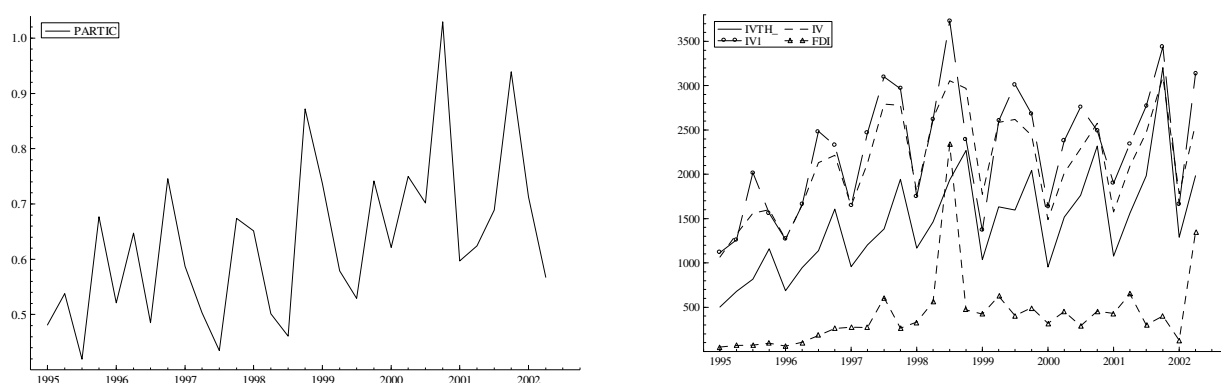
Other aspects of the modelling of investments are described: investments in sectors (Section 9.3) and investments in dwellings (Section 3.4). The equation in the model for gross domestic investment will be specified in the section below.

5.1. Data

We have data for capital investments in sectors and dwellings in current prices (*IVj*) and gross fixed capital formation in current and constant prices (*IV* and *IRN*). However, we are modelling the demand for investments in constant prices. We calculate an aggregated investment price ($PI = IV/IRN$) from total investments and use this to calculate investments in sectors in constant prices ($IRj = IVj/PI$). We implicitly make the assumption that the aggregated investment price is highly correlated with the investment price in each sector.

From Figure 9 (right), it is seen that the calculated total capital investments have a seasonal pattern and a growing trend. The share of total capital investment in the gross investments makes on average 63%, and there is an increasing tendency.

Figure 9 Total Capital Investments relative to the Gross Domestic Investment (left). Gross Investment, Gross Fixed Capital Formation, Total Capital Investment and Foreign Direct Investments in Current Prices (right)



A rapid growth in foreign direct investments in 1998q3 is explained by the privatisation of “Lietuvos telekomas”. The influence of the consequent privatisation process in Lithuania is also seen from steadily positive changes in foreign direct investment stock.

¹³ I_f and I_{nc} are not estimated in the model.

5.2. Gross Domestic Investments

As important determinants for gross domestic investments (I_D), we use total capital investments (I_C), GDP (Y), and real foreign direct investments (I_{fd}). In equation (31), we restrict α_1 to one, because total capital investments make a certain observed part of gross domestic investments (see (30)). An unobserved residual (non-material and portfolio investments) could be determined by the other included variables. Capital investments fluctuate more rapidly than gross domestic investments, and seasonal adjustments are included due to this. There is also a statistically significant effect on the Russian crisis and thus a static (long-term) equation for gross domestic investments is:

$$I_D = \alpha_0 + \alpha_1 I_C + \alpha_2 I_{fd} + \alpha_3 Y + \alpha_4 D_{RC,-1} + \lambda_2 Q_2 + \lambda_3 Q_3 + \lambda_4 Q_4 \quad (31)$$

Where

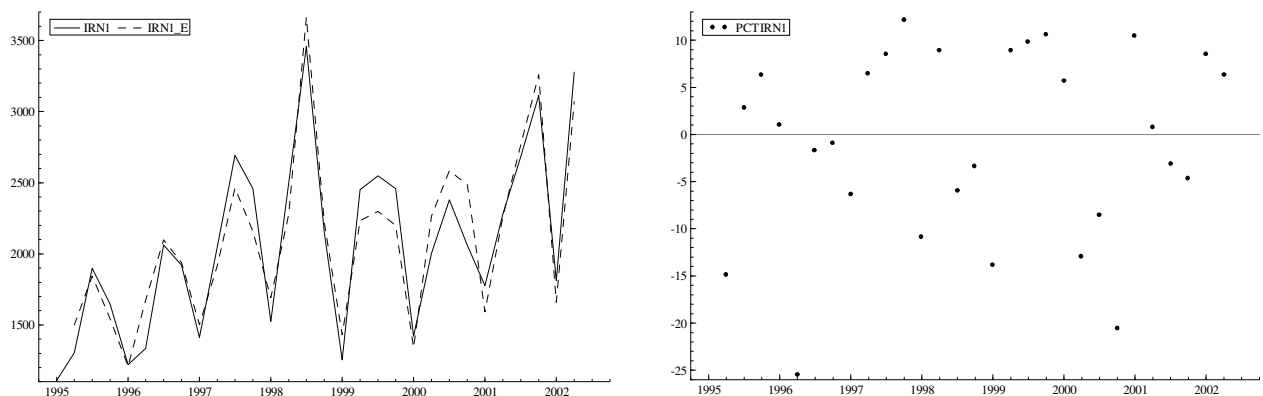
I_D	Gross domestic investment (<i>IRNI</i> , mill. Litas constant prices)
Y	Gross value added (<i>GDPT</i> , mill. Litas constant prices)
I_{fd}	Foreign direct investment (<i>FDI/PI</i> , mill. Litas constant prices)
I_C	Total capital investment (<i>IRTH</i> , mill. Litas constant prices)
D_{RC}	Dummy for Russian crisis in 1998q3
Q_2 - Q_4	Quarter dummies

Table 7 Gross Domestic Investments, Parameter Estimates

Parameter	α_0	α_1	α_2	α_3	α_4	λ_2	λ_3	λ_4
	540.978	1	.553061	0	-245.018	217.328	467.107	-162.977
	[5.57540]	*	[4.77034]	*	[-2.95464]	[1.87749]	[3.85344]	[-1.39687]
Estimation period 1995q1-2002q2; t-values in []; * restricted parameter; $R^2 = 0.893986$								

Figure 10 shows plot of residuals and fitted versus actual values.

Figure 10 Gross Domestic Investments, Fit and Residuals



6. Export

The basic set-up in the export and import modelling is an Armington model.¹⁴ Regarding import, the model idea can be described in the following way: A given Lithuanian demand for a product can either be fulfilled by domestic production or by import. Both types of supply adjust according to demand, but the composition of domestic and foreign produced goods depends on the prices of domestic production and import since the consumers prefer the cheapest. So the import share of the market is a function of relative prices. Even though the domestic and foreign produced product is essentially the same, the consumer distinguishes between them according to the country of origin; therefore, domestic and foreign produced goods are not perfect substitutes, and the same products can have different prices. The same type of model is used for exporting, since export is import from Lithuania seen from abroad.

We do not have data for the size of the export market so we use instead a weighted average of the GDP growth in the countries to which Lithuania export. As weights, we use the export shares in 2001 of Lithuania's 14 main foreign trade partners, (the calculation of Y_{World} is shown in Appendix 12.4). It is normally assumed that the export market increases faster than GDP due to an increased internationalisation. So, if we assume that the export share (export/size of export market) is in the long-run constant (usually in the Armington model), we expect export elasticity with respect to the GDP-index to be larger than one ($\alpha_1 > 1$ in (32)).

We use as price on the export market a 'World Market Price' where market prices in the three export markets (EU, Central Europe, and CIS) are weighted according to their share of export during 2001 (the calculation of the World Market Price is shown in Appendix 12.4).

If the export market competition was monopolistic,¹⁵ we would estimate a negative relationship between the export and the relative export price ($\alpha_2 < 0$ in Equation (32)). If there was perfect competition instead, the World Market Price determines the export price and the relative price is constant and cannot be used as an explanatory variable. In this case, we will see a positive relationship between export and World Market Price ($\alpha_4 > 0$ in Equation (32)). The determination of the export price in the model is described in Section 10.8.

$$\log(X^*) = \alpha_0 + \alpha_1 \log(Y_{World}) + \alpha_2 \log(p_X / p_{World}) + \alpha_4 \log(p_{World}) + \kappa \cdot D_{RC} + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (32)$$

Where

X	Export (X_{RN} , mill. Litas constant prices)
X^*	Export, equilibrium level
Y_{World}	GDP in export market, weighed index of GDP in the primary export countries (GDP_{wr} , 1995=1).
p_X	Export price (p_X , 1995=1)
p_{World}	World Market Price (wmp , 1995=1)

¹⁴ Paul Armington (1969): *A Theory of Demand for Products Distinguished by Place of Production*. IMF staff Papers, 26 (p. 159-178).

¹⁵ It is often assumed that manufacturing export is monopolistic. In Lithuania, the export of goods is much greater than export of services. Therefore, we expect to see a monopolistic competition in the aggregated export.

D_{RC} Dummy for the Russian Crisis (= 1 1998q3-)

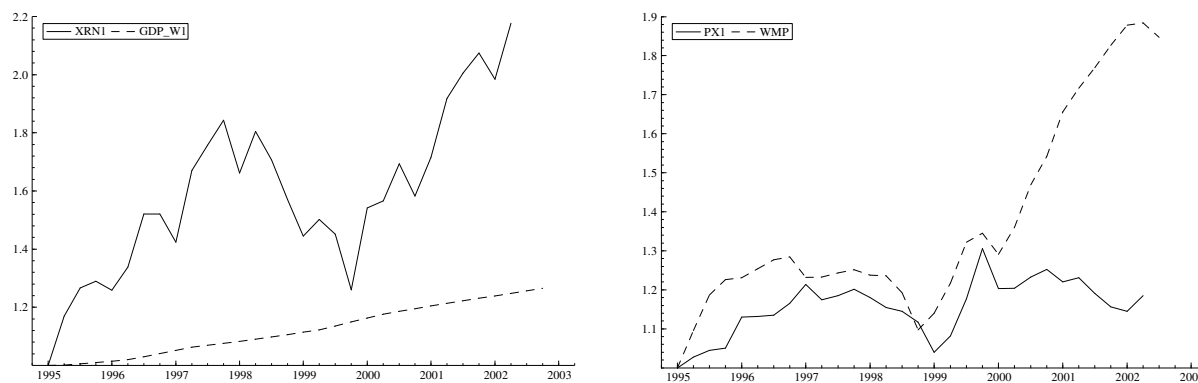
The dynamic adjustment to the long-term relation is formulated as an error correction model.

$$\begin{aligned} \text{Dlog}(X) = & \beta_1 \text{Dlog}(Y_{\text{World}}) + \beta_2 \text{Dlog}(p_X / p_{\text{World}}) + \beta_3 \text{Dlog}(p_X) + \beta_4 \text{Dlog}(p_{\text{World}}) \\ & + \kappa \cdot D(D_{RC}) + \beta_0 [\log(X_{-1}) - \log(X_{-1}^*)] \end{aligned} \quad (33)$$

We see in Figure 11 (left) that export grows faster than GDP in the export market expected for the drastic decrease in the export during 1998 and the following years. The decrease is due to the Russian crisis (in the figure, $XRN1$ is total export in constant prices equal to one in 1995q1, and GDP_w1 is the World GDP index with 1995q1=1). We use a dummy in the estimation (D_{RC}) to explain the downward shift in the export following the Russian crisis. Previously, a large share of the Lithuanian export was to the CIS countries whereas by the end of the estimation period, half of the export was to the EU. The shift in export markets was due to the Russian crisis, but we were not able to formulate an equation explaining the shift, for example, by including the growth rate in the Russian GDP. Therefore, we use a dummy in the estimation.¹⁶

We see in Figure 11 (right) that the World Market Price in the last part of the estimation period grows more rapidly than the export price ($px1$ is the export price with 1995q1=1, and wmp is the World Market Price index with 1995q1=1).

Figure 11 Export, Foreign Market and Relative Export Price



The parameter estimates from the chosen estimation are shown in Table 8, and the historical fit of the estimated equation is shown in Figure 12.

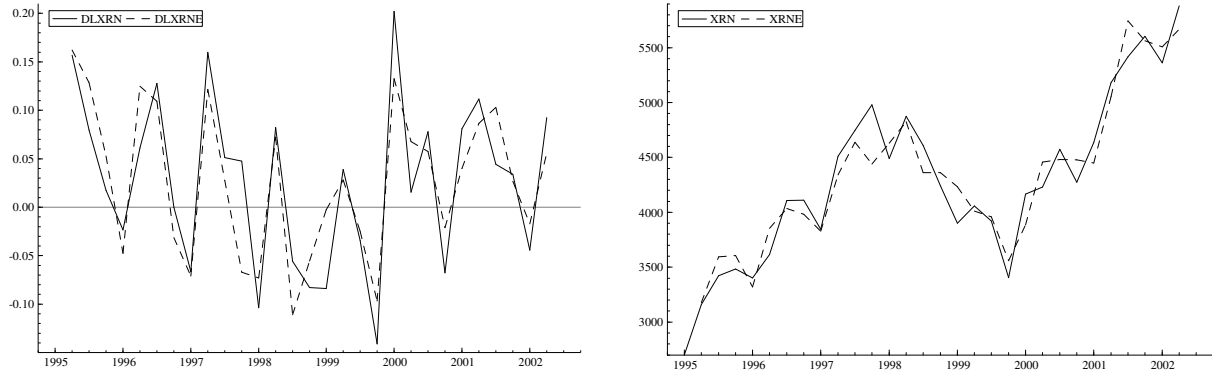
Table 8 Parameter Estimates, Export Relation

α_0	α_1	α_2	α_4	κ	λ_2	λ_3	λ_4	β_0	β_1	β_2	β_3	β_4
8.355	1.571	-0.514	0	-0.147	0.010	-0.167	-0.230	-0.405	0	0	-1.124	0
[90.9]	[2.08]	[-1.73]	*	[-2.39]	[0.14]	[-1.71]	[-2.31]	[-3.87]	*	*	[-4.09]	*
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.729213$												

¹⁶ In macro-econometric models, it is often difficult to explain shifts in export when there is major changes in the export market, e.g., the Danish macro-econometric models use a dummy to explain changes in export following the German reunification.

In the long-run equation, the parameter to the relative export price (α_2) is negative indicating a monopolistic competition on the export market.¹⁷ In the dynamic equation, only changes in the export price changes the export ($\beta_3 < 0$, $\beta_2 = 0$, $\beta_4 = 0$). If the World GDP increases by 1%, the export increases in the long-run by 1.6% ($\alpha_1 = 1.571$), but there is no effect on the first quarter ($\beta_1 = 0$).

Figure 12 Export, Fit of Estimated Equation



7. Import

Based on the Armington-model, we established the same basic demand equation for import as we did for export.

The domestic demand for import could be calculated as the demand components weighted by their import contents – unfortunately, deliveries in the Input-Output table are not distinguished between import and domestic production. We choose to use private consumption as proxy for the domestic demand for import and the consumer price as the relative price.

$$\log(M^*) = \alpha_0 + \alpha_1 \log(Y_{import}) + \alpha_2 \log(p_M / p_C) + \alpha_3 D_{RC} + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (34)$$

$$D\log(M) = \beta_1 D\log(Y_{import}) + \beta_2 D\log(p_M / p_Q) + \alpha_3 D(D_{RC}) + \beta_0 [\log(M_{-1}) - \log(M_{-1}^*)] \quad (35)$$

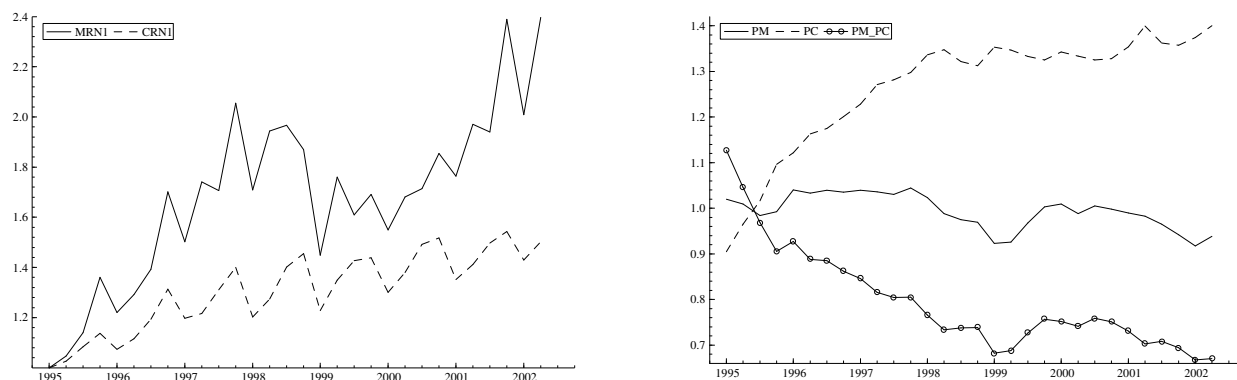
Where

M	Import total (MRN , mill. Litas constant prices)
M^*	Import equilibrium level
Y_{import}	Domestic demand for import (private consumption CRN , mill. Litas constant prices)
p_M	Price on import (1995=1)
p_C	Price on private consumption (1995=1)
D_{RC}	Dummy for the Russian Crisis (= 1 1998q3-)

¹⁷ In the former LITMOD sector model, a monopolistic competition was also estimated, and there was a larger coefficient to the relative export price in the export of manufacturing than in the export of service.

We see in Figure 13 (left) that import grows faster than the domestic demand (MRN1 and CRN1 is equal to one in 1995q1) – except for the drop in import after 1998 (we use a dummy in the estimation to explain the change due to the Russian crisis). In the figure to the right, we see that the import price relative to the domestic consumer price (PM_PC) was decreasing until the beginning of 2000 whereafter it remained mostly constant.

Figure 13 Import, Domestic Demand, and Relative Price



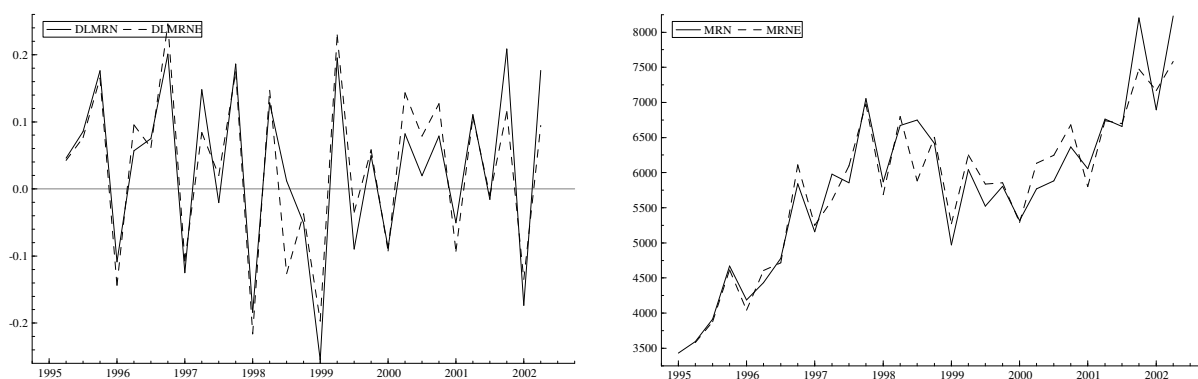
The chosen estimation is presented in Table 9. The estimated short-run demand elasticity (β_1) is larger than the long-run demand elasticity (α_1). This indicates that domestic production cannot in the short-run fulfil increased demand. The import is largely influenced by the import price relative to the consumer price - the long-term price elasticity is -0.8 (α_2) and the short-run elasticity is -1.4 (β_2). The adjustment towards the long-run equilibrium is quick ($\beta_0 = -0.879$).

Table 9 Parameter Estimates, Import Relation

Param	α_0	α_1	α_2	α_3	λ_2	λ_3	λ_4	β_0	β_1	β_2
	-5.991	1.709	-0.807	-0.212	-0.093	-0.031	0.059	-0.879	2.175	-1.364
	[-1.90]	[4.51]	[-2.54]	[-4.69]	[-1.82]	[-0.64]	[0.66]	[-3.72]	[4.03]	[-2.64]
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.854911$										

The historical fit of the relation is shown in Figure 14 (changes in the left figure and level in the right figure). The relation catches almost all changes in the import.

Figure 14 Import, Fit of Equation



8. Domestic Production, Intermediate, and GDP

8.1. Domestic Production

We determine the domestic production in the 12 sectors by using the Input-Output coefficients. The problem is that only one set of Input-Output coefficients is available, and they are based on yearly data from 1997. Therefore, we need some corrections, which are described in the following sections.

8.1.1. Import Correction

Using equation (5) to determine production in the model causes problems when the model is simulated. Production may become negative in some sectors when import is subtracted from the total supply. Instead, we use the formulation (36) used in the first LITMOD. Using the Input-Output table, the import share coefficients am_j are calculated as M_j/Q_j . This ensures that the calculated production is always positive.

$$\begin{aligned} Supply_j &= Q_j + M_j = Q_j + am_j \cdot Q_j = (1 + am_j) \cdot Q_j = \sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k \\ \Leftrightarrow Q_j &= \frac{1}{(1 + am_j)} \cdot (\sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k) \end{aligned} \quad (36)$$

Import (M) is then indirectly determined as (37), but we will also have a demand equation for import in the model (see Section 7).

$$M = \sum_{j=A, \dots, S4} am_j \cdot Q_j \quad (37)$$

The solution is to determine the import share coefficients (am_j) endogenously so that they depend on the import that is determined in the import demand equation. From (36) and (5), we obtain relation (38), which is used in the model. The time series for the import share coefficients are calculated in the same way.

$$m_j \cdot M = am_j \cdot Q_j \quad \Leftrightarrow \quad am_j = (m_j \cdot M) / Q_j \quad (38)$$

The import coefficients are shown in Table 10. The am_j 's are calculated here by using the 1997 Input-Output table. However, they are not constant in the model.

Table 10 Import Coefficients in Equations for Domestic Production

Sector	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
am_j	0.162	0.000	0.822	1.886	2.131	0.330	0.476	0.055	0.145	0.259	0.102	0.001
m_j	0.053	0.000	0.151	0.224	0.237	0.162	0.015	0.012	0.060	0.066	0.019	0.000

8.1.2. Corrections between Sectors and Quarters

The input-output coefficients are calculated on the basis of yearly data. However, there are different seasonal variations in production and demand (change of stocks), especially in the agricultural sector (A). Therefore, we need to model some seasonal adjustment in these equations. Furthermore, we only have input-output coefficients for one year (1997), and there has clearly been structural changes between the sectors. We, therefore, estimate changes in the production level between the sectors. The estimated adjustments ensure that the total

yearly production is determined by the aggregated demand by using the input-output coefficients. The different parts of the equation and restrictions are explained below:

$$\begin{aligned}
 (1 + am_j) \cdot Q_j = & \left[\sum_i a_{ji} \cdot Q_i + \sum_k a_{jk} \cdot X_k \right] \\
 & + \left[\lambda_{j1} \cdot Q_1 + \lambda_{j2} \cdot Q_2 + \lambda_{j3} \cdot Q_3 + \lambda_{j4} \cdot Q_4 \right] \\
 & + \left[\alpha_{j0} + \alpha_{j1} \cdot t + \alpha_{j2} \cdot D_{RC} \right]
 \end{aligned} \tag{39}$$

Where

am_j	Import share coefficients ($a_{jimp} = a_{jIm} \cdot MRN / QR_j$)
Q_j	Production in sector j (QR_j , mill. Litas constant prices)
X_k	Final consumption component k ($X_k = CRN, CGRN, IRN1, XRN$; mill. Litas constant prices)
a_{ji}	Input-Output coefficient for deliveries from sector j to sector i ($a_{ji}, j, i = A, \dots, S4$)
a_{jk}	Input-Output coefficient for deliveries from sector j to final consumption component k ($a_{jk}, k = cp, cg, ir, ex$)
D_{RC}	Dummy for the Russian crisis ($D_{RC} = 1$ 1998q3-)
t	Time
Q_2 - Q_4	Quarterly dummies; Q_2 is equal to one in second quarter and otherwise zero

- The first square bracket is the Input-Output determination for supply of type j based on a set of I-O coefficients from 1997. Total supply equals total demand.
- The second square bracket is quarterly dummies, i.e., a dummy for each quarter in each sector. The adjustment during the year adds to zero with restriction (40). This can be seen as a (simple) modelling of changes in stocks during the year for each sector (e.g., agricultural production). Yearly production in each sector remains unchanged.

$$\lambda_{j1} + \lambda_{j2} + \lambda_{j3} + \lambda_{j4} = 0, \quad j = A, \dots, S4 \tag{40}$$

- The third square bracket is shifts between sectors (level (41) and trend (42)). α_{j1} is additional million Litas of production in sector j in each quarter. Total production remains unchanged.

$$\sum_{j=A, \dots, S4} \alpha_{j0} = 0 \tag{41}$$

$$\sum_{j=A, \dots, S4} \alpha_{j1} = 0 \tag{42}$$

- Changes in production structure due to the Russian crisis (43). Total production remains unchanged.

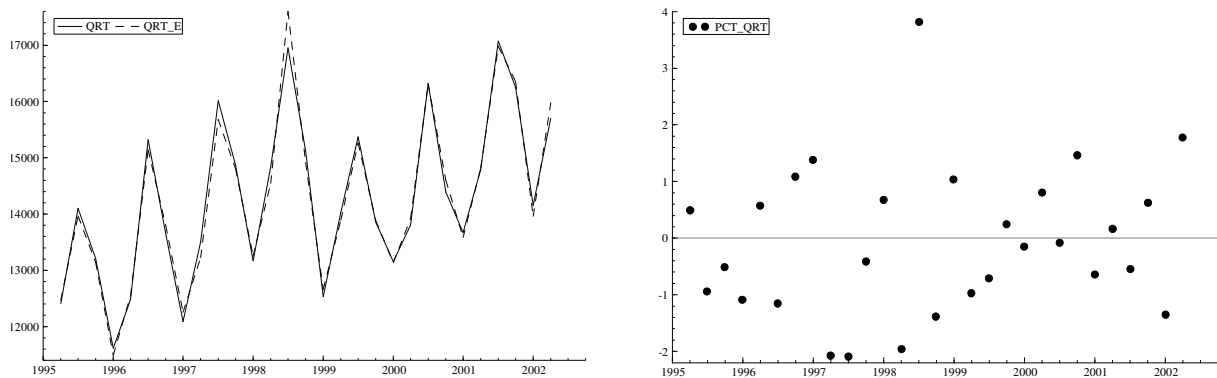
$$\sum_{j=A, \dots, S4} \alpha_{j2} = 0 \tag{43}$$

In the estimation, we impose the three last restrictions in sector S4 (same results if imposed upon in any other sector).

Furthermore, we allow an AR1 process in the residuals in sectors C and S3. This improves the explanation significantly, but if we do not include this process, the estimated value of the aggregated production is less than the actual production. We can explain the use of the AR-process as stock changes, not only in the year between quarters, but also between years.

As seen in Figure 15, the estimated value of the aggregated production is quite close to the actual production. The remaining error in the aggregated production is (probably) due to the fact that actual values for total supply and total demand is not exactly equal in the entire estimation period.

Figure 15 Aggregated Domestic Production, Fit and Residuals



8.2. Intermediate

We have from the Input-Output table the following relations that determine intermediate (deliveries) between sectors (44). Intermediate used in sector j (C_j , ‘consumption’ in sector j) is then a constant share of production in sector j where the share is given by the sum of I-O coefficients a_{ij} (deliveries from sector i to sector j). The sum of the I-O coefficients in each sector is shown in Table 11; about half of the production in the sectors is based on deliveries from other sectors.

$$C_j = Q_j \cdot \sum_i a_{ij} \quad (44)$$

Table 11 Intermediate as Share of Production

Sector	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
$\sum_i a_{ij}$	0.501	0.546	0.546	0.642	0.664	0.655	0.602	0.511	0.347	0.472	0.277	0.370

Intermediate is delivered from other sectors or imported. Using the I-O coefficients (44) we calculate the intermediate delivered from other sectors, and this is lower than the actual intermediate as seen in Figure 16 (left). We assume that import is a constant share of the intermediate and hence formulate the demand for intermediate proportional with the I-O-calculated intermediate.

Therefore, we extend the equation with proportionality of the I-O-calculated intermediate (α_1), a constant term (α_0), a time trend (α_2), quarterly dummies (λ_2 – λ_4), and a dummy for the Russian crisis (α_3) - as used in the production equations. As seen in Figure 16 (right), there is an almost perfect fit of the total intermediate, and there are only some deviations in the service sectors.

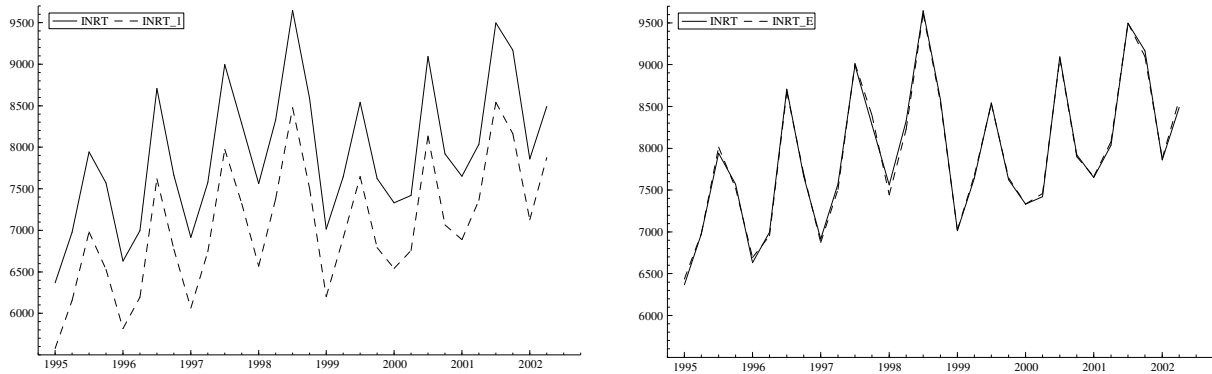
$$C_j = \alpha_{0j} + \alpha_{1j} \cdot Q_j \cdot \sum_i a_{ij} + \alpha_{2j} \cdot t + \alpha_{3j} \cdot D_{RC} + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (45)$$

Where

C_j	Intermediate in sector j (INR_j , mill. Litas constant prices)
Q_j	Production in sector j (QR_j , mill. Litas constant prices)
a_{ij}	Input-Output coefficient for deliveries from sector i to sector j
D_{RC}	Dummy for the Russian crisis ($D_{RC} = 1$ 1998q3)
t	Time
Q_2 – Q_4	Quarterly dummies; Q_2 is equal to one in second quarter and else zero

The dummy (α_3) is only needed in sector S1, and the quarterly dummies are only needed in sectors E, MN, S1, and S4. The estimated time trend ($\alpha_2 < 0$) is negative indicating that the production has become more labour and capital intensive during the estimation period.

Figure 16 Intermediate (left: I-O-based, right: estimated)



We could later extend the model and add (estimated) demand equations for energy use and other intermediates.

8.3. Gross Value Added and GDP

Production consists of intermediate and gross value added (capital and labour), and we will, therefore, determine gross value added in the model for each sector (Y_j) as (46).

$$Y_j = Q_j - C_j \quad (46)$$

We use the national accounts ideology in the model for the calculation of GDP. We estimate GDP by using the production and expenditure approaches. By first approach, GDP is the net value of the goods and services produced within the country during the reference period. In other words, the gross value added is firstly estimated as a sum of value added by every

activity, i.e., gross output less intermediate consumption as stated in (46). Then, the gross value added by all types of activity at basic prices plus taxes on products minus subsidies on products forms GDP at market prices:

$$Y = P_Y \cdot \sum_j Y_j + R_v \quad (47)$$

Where

Y	GDP ($GDPV$, mill. Litas in current prices)
Y_j	Gross value added in sector j ($GDPj$, mill. Litas constant prices)
P_Y	GDP price index ($pgdp$, 1995=1)
R_v	Revenue from VAT paid by households ($CGREVV$, mill. Litas current prices)

Calculating GDP by expenditure approach (constant prices) is (48), and this is almost equal to GDP calculated by using production in sectors (47).

$$Y^* = X - M + I_D + C_p + C_G \quad (48)$$

Where

Y^*	GDP (GDP , mill. Litas constant prices)
X	Export (XRN , mill. Litas constant prices)
M	Import (MRN , mill. Litas constant prices)
I_D	Domestic investments ($IRNI$, mill. Litas constant prices)
C_p	Private consumption (CRN , mill. Litas constant prices)
C_G	Public consumption ($CGRN$, mill. Litas constant prices)

8.4. Current Account and Balance of Payment

The balance of payments is an important measure in relation to the formulation of economic policy. It expresses the economical transactions of the country with the rest of the World in terms of value over a specific period of time. The balance of payment consists of the following components:

- Current account, which shows bilateral transactions of trade and services, interest and dividends collected and paid, as well as transfers;
- Capital and financial account, which records transactions with non-residents in non-production, non-financial assets, as well as capital transfers;
- Reserve assets.

We should notice that, in principal, balances of the three main balance of payment parts are interlinked by the equation: the current account balance (with the opposite sign) equals the sum of the capital and financial account balance and changes in net official reserves. However, in practice, due to accounting errors and non-recorded transactions, accounts do

frequently not balance. Differences are shown in a separate entry of the balance of payments called errors and omissions.

We concentrate in this model on the current account only (other parts and the identity for balance of payment are linked with the monetary block excluded from the present version of the model).

$$CA = P_X \cdot X + I_{BAL} + NT - P_M \cdot M \quad (49)$$

Where

CA	Current account balance (CA , mill. Litas, current prices)
P_X	Export price (PX , 1995=1)
P_M	Import price (PM , 1995=1)
X	Export of goods and services (XRN , mill. Litas, current prices)
M	Import of goods and services (MRN , mill. Litas, current prices)
I_{BAL}	Income balance ($INBAL$, mill. Litas, current prices)
NT	Net transfers (NT , mill. Litas, current prices)

9. Factor Demand

In order to produce, companies use three production factors: commodities (intermediate from other sectors and import), labour, and capital. The demand for commodities is described in Section 8.2. The demand for labour in the 12 sectors is described in Section 9.2, and the demand for capital in the sectors is formulated as a demand for investments in Section 9.3.

We start out by formally stating a production function. The problem, at this moment, is that there is no official data on the capital stock (see Section 5), so ‘capital demand’ has to be formulated as an investment relation. Therefore, we end up estimating separate demand equations for labour and investments in sectors as an approximation to theoretical more correct demand equations.

9.1. Production Function and Factor Demand Equations

Production is described by a nested production function with three production factors (intermediate C , labour L , and capital K) shown in (50) and illustrated in Figure 17. We assume weak separability between intermediate and the aggregation of labour and capital.

$$\begin{aligned} Q &= g(C, K, L) = h(C, Y) \\ Y &= f(K, L) \end{aligned} \quad (50)$$

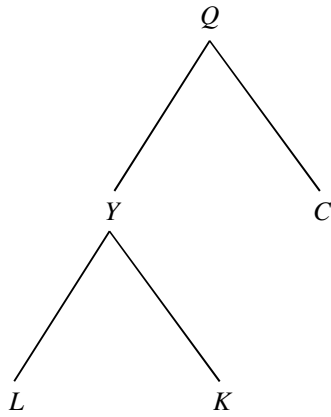
The optimisation problem for companies is to minimise production costs subject to a fixed level of production.

$$\begin{aligned} \text{Min}_{\{C, L, K\}} \text{Costs} &= P_C \cdot C + P_L \cdot L + P_K \cdot K \\ \text{s.t.} \quad Q &= g(C, K, L) = h(C, Y) = h(C, f(K, L)) \end{aligned} \quad (51)$$

Where

Q	Production in sector j
Y	GDP in sector j
C	Intermediate in sector j
L	Labour (hours) in sector j
K	Capital stock in sector j
P_C	Price on intermediate in sector j
P_L	‘Price’ on labour
P_K	‘Price’ on capital – user cost
f, g, h	Production functions

Figure 17 Factor Demand



We assume that intermediate is a constant share of production (this is a standard assumption in macro-economic models). With this assumption, the outer production function (h) is a Leontief function and the demand for intermediate (and GVA) is given by (52). As described in Section 8.2, we model the demand for intermediate using the input-output coefficients (45) and GVA (Y) as (46).

$$\begin{aligned}
 C &= \kappa \cdot Q \\
 Y &= (1 - \kappa) \cdot Q = Q - C
 \end{aligned} \tag{52}$$

Looking at the demand for labour and capital, GVA is given from the above equation and companies should minimise costs to labour and capital. Using Lagrange optimisation solves this.

$$\begin{aligned}
 & \text{Min}_{\{K, L\}} P_K \cdot K + P_L \cdot L \\
 & \text{s.t.} \quad Y = f(K, L)
 \end{aligned} \tag{53}$$

Depending on the choice of inner production function f , we will have different long-term demand equations for L and K . In the following, we describe the three most commonly used production functions.

The simplest choice of a production function is the Leontief function assuming no substitution between the two production factors shown in (54). Contrary to no substitution, the Cobb-

Douglas production function assumes full substitution. The Cobb-Douglas function is formulated in (55) where the parameter β is the capital output elasticity. The CES function (Constant Elasticity of Substitution) is between the two extreme cases of substitution and assumes a constant elasticity of substitution (probably below one) between labour and capital. The CES function is formulated in (56) where the parameter σ is the elasticity of substitution between capital and labour.

$$Y = f_{Leontief}(K, L) = \min\{K, L\} \quad (54)$$

$$Y = f_{C-D}(K, L) = K^\beta L^{1-\beta} \quad (55)$$

$$Y = f_{CES}(K, L) = \left[\delta_1 K^{\frac{\sigma-1}{\sigma}} + \delta_2 L^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (56)$$

We may from these production functions obtain the following demand equations for labour and capital, respectively: (57) assumes a Leontief function where demand is a constant share of GDP, (58) assumes a Cobb-Douglas function, and (59) assumes a CES function with P_{KL} being the CES price index. We assume throughout constant return to scale so that the parameter to $\log(Y)$ is one in the demand equations.

$$\begin{aligned} \log(L_L^*) &= \kappa_L + \log(Y) \\ \log(K_L^*) &= \kappa_K + \log(Y) \end{aligned} \quad (57)$$

$$\begin{aligned} \log(L_{C-D}^*) &= \alpha_L + \log(Y) - \beta \log\left(\frac{P_L}{P_K}\right) \\ \log(K_{C-D}^*) &= \alpha_K + \log(Y) - (1-\beta) \log\left(\frac{P_K}{P_L}\right) \end{aligned} \quad (58)$$

$$\begin{aligned} \log(L_{CES}^*) &= \log(Y) + \sigma \log(\delta_2) - \sigma \log\left(\frac{P_L}{P_{KL}}\right) \\ \log(K_{CES}^*) &= \log(Y) + \sigma \log(\delta_1) - \sigma \log\left(\frac{P_K}{P_{KL}}\right) \end{aligned} \quad (59)$$

$$P_{KL} = \left[\delta_1^\sigma P_K^{1-\sigma} + \delta_2^\sigma P_L^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

Substitution between labour and capital implies that the effect of the factor price ratio or the relative factor price has to be negative.

Since we do not have data for the capital stock within sectors, we cannot directly use equations (57) to (59). Instead, we will formulate an equation for investment demands. As a starting point, we use a CES production function, but we make some simplifying assumptions. We use the producer price (P_{Qj}) instead of the CES price index (P_{KL}), and estimate separate price elasticities (σ 's) in the demand equation for labour and investments. If the elasticity is equal to zero, we will have a Leontief production function.

As seen in Table 12, the most labour-consuming sectors are public sector (S4), manufacturing of non-durable (M3), and trade, etc. (S1). The most investment-consuming sectors are transport and communication (S2), the public sector (S4), and trade, etc. (S1).

Table 12 Average Size of Sectors 1995-2001

Sector	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
Share in %												
Output	13	1	9	4	5	19	1	7	14	9	7	12
Investment	3	1	12	3	3	12	1	2	13	29	7	14
Labour	7	0	4	3	4	14	1	7	12	8	6	34
Intermediate	14	0	13	5	6	24	2	8	9	8	4	9

9.2. Labour Demand

A log linear long-term demand equation for fulltime workers is formulated for each sector in (60) with an error correction model to describe the dynamic adjustment (61). L is the number of hours worked per week divided by 40 (fulltime), so L is the number of employees who have worked full days.

In the long-run, we assume constant return to scale ($\alpha_2 = 1$), meaning that a 1% increase in GVA increases labour demand by 1%. The labour demand depends negatively on the relative wage ($\alpha_3 < 0$). We could estimate a significant long-term effect of relative wage in three sectors only (the three sectors are A, M3, and C and accounts for approximately 25% of total employment) and no short-term wage effect ($\beta_3 = 0$). We include a time-trend as a proxy for labour productivity (α_1).

The population census, which took place in 2000q1, initiated some rapid corrections in the level of labour within sectors, i.e., data before and after this census became incomparable. However, if the re-calculated data for population has been backdated, the time series for labour demand were not. Therefore, we include a dummy for the population census (D_{PC}), (in sectors MN, S3 and S4, the dummy variable is lagged one year).

$$\log(L^*) = \alpha_0 + \alpha_1 t + \alpha_2 \log(Y) + \alpha_3 \log(w/P_Q) + \alpha_4 D_{PC} + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (60)$$

$$D\log(L) = -\beta_0 [\log(L_{-1}) - \log(L^*)] + \beta_2 D\log(Y) + \beta_3 D\log(w/P_Q) + \alpha_4 D(D_{PC}) \quad (61)$$

Where

L	Labour demand in sector j (LNj , 1000 fulltime employed workers)
L^*	Labour demand in sector j , equilibrium level
Y	GVA in sector j ($GDPj$, mill. Litas constant prices)
w	“Wage” (average monthly gross earnings for fulltime employed), ($wpri$ and $wpub$, Litas)
P_Q	Producer price in sector j (PQj , 1995=1)

D_{PC}	Dummy due to Population Census ¹⁸ ($dumPCen$, = 1 from 2000q1)
t	Time
Q_2 - Q_4	Quarterly dummies; Q_2 is equal to one in second quarter and else zero

Some of the parameters are restricted in the estimations; they were either insignificant or had the wrong sign. The chosen estimations are summarised in Table 13. The parameter to the time index (α_1) is negative (or zero) implying increasing labour productivity, or that less labour is needed over time to produce the same amount. Labour productivity increases up to 3% each quarter, which is extremely high and it should be modified in the medium to long-term forecasts. However, over the estimation period, the average labour productivity increased by approximately 0.9% each quarter.¹⁹ The average long-term price elasticity is – 0.1. The adjustment towards the long-term relation (β_0) is rather slow in agriculture and manufacturing sectors and quick in construction and the private service sectors.

Table 13 Labour Demand, Parameter Estimates

Parameter	A	MN ¹	E	M1	M2	M3	M4	C	S1	S2	S3 ¹	S4 ¹
α_0	0.855 [0.44]	-1.971 [-3.37]	-1.757 [-13.5]	-1.931 [-13.8]	-1.433 [-7.24]	1.468 [1.02]	-1.425 [-5.18]	3.522 [2.49]	-2.263 [-26.0]	-1.858 [-27.0]	-2.419 [-54.5]	-0.878 [-17.1]
α_1	-0.024 [-1.71]	0 *	0 *	-0.012 [-2.16]	-0.027 [-4.23]	-0.012 [-1.34]	-0.030 [-2.24]	0 *	0 *	-0.016 [-4.40]	-0.007 [-2.54]	-0.007 [-2.24]
α_2	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *
α_3	-0.326 [-1.09]	0 *	0 *	0 *	0 *	-0.446 [-2.01]	0 *	-0.761 [-3.59]	0 *	0 *	0 *	0 *
α_4	-0.339 [-4.41]	-0.368 [-2.95]	-0.031 [-1.19]	-0.108 [-2.07]	-0.089 [-1.79]	-0.104 [-2.07]	-0.118 [-2.33]	-0.122 [-1.89]	-0.252 [-5.64]	-0.142 [-2.51]	-0.070 [-1.29]	-0.064 [-4.42]
λ_2	-0.431 [-3.28]	-1.390 [-2.03]	-0.142 [-0.94]	0.172 [1.31]	0.274 [1.86]	0 *	0 *	-0.300 [-2.52]	-0.011 [-0.12]	-0.085 [-1.48]	0.065 [1.44]	0 *
λ_3	-1.551 [-5.95]	-2.009 [-2.54]	-0.302 [-1.27]	0.003 [0.04]	0.265 [1.61]	0 *	0 *	-0.222 [-1.18]	-0.133 [-1.56]	0.012 [0.17]	0.009 [0.20]	0 *
λ_4	-0.528 [-2.97]	1.061 [1.11]	-0.361 [-2.21]	0.209 [1.72]	0.325 [1.62]	0 *	0 *	0.363 [1.13]	0.214 [1.11]	0.078 [1.01]	0.142 [2.54]	0 *
β_0	0.284 [2.90]	0.1 *	0.1 *	0.256 [2.82]	0.191 [3.32]	0.302 [2.89]	0.110 [1.78]	0.509 [2.41]	0.447 [3.43]	0.529 [2.98]	0.8 *	0.1 *
β_2	0 *	0.147 [1.65]	0.067 [2.37]	0.152 [2.60]	0 *	0.108 [1.23]	0.103 [2.21]	0.621 [3.28]	0.247 [1.22]	0.490 [2.78]	1.289 [2.71]	0.065 [4.07]
β_3	0 *	0 *	0 *	0 *	0 *	0 *	0 *	0 *	0 *	0 *	0 *	0 *
R^2	0.786	0.563	0.246	0.592	0.659	0.489	0.369	0.731	0.685	0.467	0.653	0.581

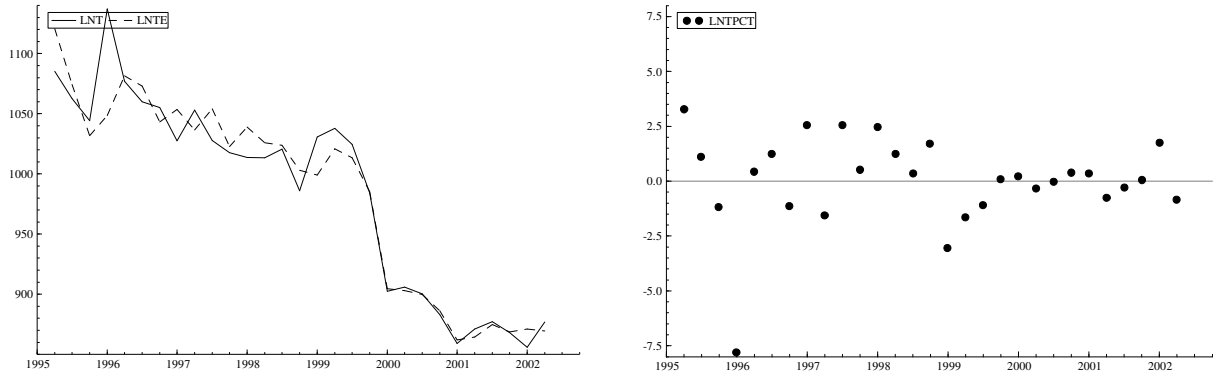
Estimation period 1995q2-2002q2; t-values in []; * restricted parameter; ¹ dummy lagged one year

¹⁸ Though Population Census in Lithuania took place in 2001q1, we use one dummy for either the effect of this census or for other factors, which influenced labour demand and other endogenous variables during this period. According to R. Rudzkis, in the case of labour demand, one of these factors could be compulsory Health Insurance law, by which an unemployed person not registered at the Lithuanian labour exchange has to pay for any medical treatment and service. This reason caused an increase in unemployment and hence a decrease in the number of employed.

¹⁹ Average labour productivity is calculated as $-100 \cdot \alpha_1$, where α_1 is calculated as $\alpha_1 = \sum_j \alpha_{1j} \cdot L_j / \sum_j L_j$.

The overall fit aggregated over the 12 sectors is shown in Figure 18. We see a large decrease in aggregated labour prior to year 2000, which we account for with the dummy. The residuals are less than 5% (except in 1996q1). The fit is not as good in all sectors, but the overall picture is acceptable.

Figure 18 Aggregated Labour Demand, Fit and Residuals



9.3. Investments

We formulate a log linear long-term demand equation for investments in each sector (62) with an error correction model to describe the dynamic adjustment (63). We assume constant return to scale in the long run ($\alpha_2 = 1$), meaning that a 1% increase in GVA increases investments with 1% and thereby also capital with 1%.

User-cost on capital depends on the investment price, interest rate, depreciation rate, and expected inflation. When estimating the demand for investment, we use the investment price relative to the producer price and the interest rate. If the interest rate increases, it will be more expensive to finance investment and investments will decrease ($\alpha_4 < 0$).²⁰

$$\log(I^*) = \alpha_0 + \alpha_1 t + \alpha_2 \log(Y) + \alpha_3 \log(P_I / P_Q) + \alpha_4 i + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (62)$$

$$D\log(I) = -\beta_0 [\log(I_{-1}) - \log(I^*)] + \beta_2 D\log(Y) + \beta_3 D\log(P_I / P_Q) + \beta_4 D(i) \quad (63)$$

Where

I	Investments in sector j (IRj , mill. Litas)
I^*	Investments in sector j , equilibrium level
Y	GDP in sector j ($GDPj$, mill. Litas constant prices)
P_I	Investment price (pi , 1995=1)
i	Interest rate (ra , %)
P_Q	Producer price in sector j (PQj , 1995=1)
t	Time
Q_2 - Q_4	Quarterly dummies; Q_2 is equal to one in second quarter and otherwise zero

²⁰ Since the interest rate is measured in percentage, we use interest rate and not log of interest rate as explanatory variable. This way, if interest rate increases from, e.g., 5% to 6%, investments will in the long-run decrease by $\alpha_4\%$. Whereas a 1% increase in the wage will in the long-run decrease investment with $\alpha_3\%$.

Many of the parameters are restricted in the chosen estimation shown in Table 14. There is a positive time-trend (α_1) in most sectors, meaning that in order to produce the same amount, more investments are needed.²¹ The average capital productivity is -1% every quarter in the beginning of the estimation period and is increased to 0.8% at the end of the estimation period.

We are only able to estimate a long-run effect of the relative investment price ($\alpha_3 < 0$) in three sectors, and there is a short-run negative effect of changes in relative investment price ($\beta_3 < 0$) in four sectors. The estimated price elasticities are huge and so the average long-term price elasticity is -0.7 .

There is a negative effect in most sectors from the interest rate ($\alpha_4 < 0$, $\beta_4 < 0$). An increase in production has a large positive short-run effect on the investments ($\beta_2 > 0$). The adjustment towards the long-term relationship is quite quick (β_0).

Table 14 Investments in Sectors, Parameter Estimates

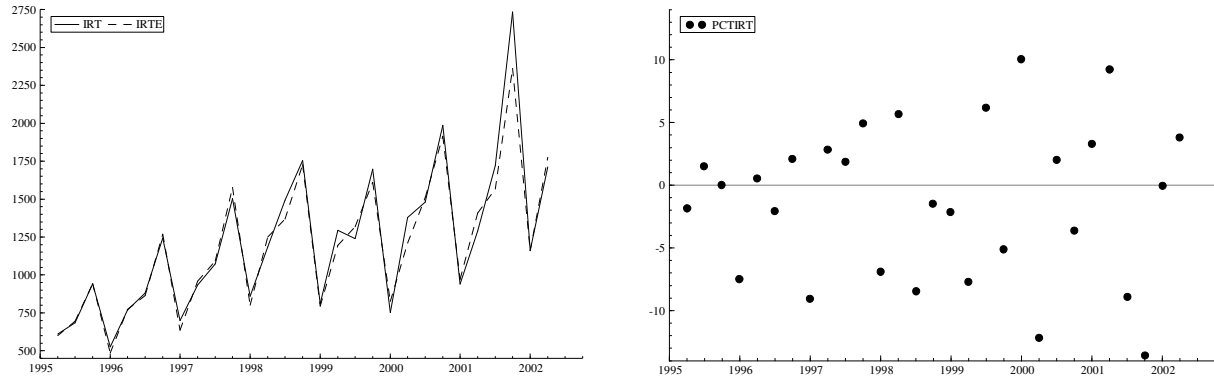
Parameter	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4
α_0	-1.386 [-0.79]	0.073 [0.08]	0.907 [1.96]	-0.959 [-2.33]	-2.705 [-10.9]	-2.206 [-16.4]	-3.508 [-10.8]	-3.172 [-4.48]	-3.081 [-17.6]	0.975 [2.94]	-2.961 [-12.7]	-1.046 [-4.10]
α_1	0 *	-0.081 [-2.00]	0 *	0 *	0.033 [3.42]	0.022 [4.70]	0.070 [3.70]	0.052 [3.37]	0.041 [3.04]	-0.060 [-4.35]	0.064 [7.94]	0 *
α_2	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *	1 *
α_3	0 *	-2.036 [-1.62]	0 *	0 *	0 *	0 *	0 *	0 *	-1.724 [-1.11]	-1.453 [-2.06]	0 *	0 *
α_4	0 *	0 *	-0.065 [-5.94]	-0.034 [-1.64]	0 *	0 *	0 *	-0.028 [-1.27]	0 *	-0.059 [-4.48]	0 *	-0.033 [-3.52]
λ_2	-2.369 [-1.16]	-0.766 [-0.90]	-0.157 [-0.53]	0.180 [0.53]	0.420 [1.62]	-0.081 [-0.64]	0 *	-0.507 [-2.29]	-0.075 [-0.51]	-0.022 [-0.22]	-0.157 [-0.66]	-0.114 [-0.60]
λ_3	-0.185 [-0.11]	-0.206 [-0.23]	0.442 [1.29]	0.132 [0.38]	0.575 [2.34]	0.458 [2.81]	0 *	0.489 [0.84]	0.419 [2.42]	0.195 [2.11]	-0.091 [-0.40]	0.289 [1.64]
λ_4	-4.256 [-1.04]	-1.690 [-1.18]	-2.725 [-2.34]	-0.947 [-1.55]	0.019 [0.08]	-0.148 [-0.70]	0 *	0.269 [0.39]	-0.379 [-1.26]	-0.648 [-6.85]	-0.793 [-2.18]	-1.289 [-2.37]
β_0	0.251 [1.27]	0.586 [2.88]	0.373 [2.91]	0.513 [3.03]	0.758 [3.91]	0.862 [4.12]	0.9 *	0.821 [3.62]	0.9 *	0.9 *	0.796 [3.99]	0.680 [3.97]
β_2	0.621 [1.72]	0.662 [1.23]	0.270 [1.58]	0 *	0.813 [1.88]	1.240 [2.34]	0 *	1.187 [2.13]	0.826 [1.08]	0 *	0 *	0 *
β_3	-0.661 [-2.00]	-0.931 [-1.56]	0 *	0 *	0 *	-0.315 [-1.10]	0 *	-1.904 [-1.31]	0 *	0 *	0 *	0 *
β_4	0 *	0 *	0 *	0 *	-0.116 [-2.12]	-0.037 [-1.19]	0 *	0 *	0 *	-0.031 [-1.05]	0 *	0 *
R^2	0.893	0.693	0.956	0.618	0.716	0.880	0.711	0.857	0.881	0.926	0.726	0.906

Estimation period 1995q2-2002q2; t-values in []; * restricted parameter

The estimated relations explain the major part of aggregated investments. Figure 19 (right) shows that the percentage residuals increase over the estimation period (probably because quarterly changes in investments also increase).

²¹ One explanation can be that production becomes more capital intensive over time as well as less labour-intensive.

Figure 19 Aggregated Investment Demand, Fit and Residuals



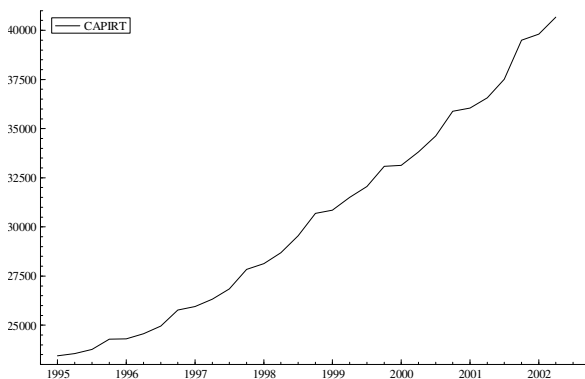
9.4. Capital Formation

The capital stock is estimated by applying the Perpetual Inventory Method (PIM): The capital stock is equal to past investment (net of depreciation) plus the initial capital stock. We use total capital investments in sectors for the flow of past investments, $I_T = \sum_j I_j$, i.e., our capital stock only includes capital (material and buildings) investments. The capital accumulation identity for the calculation of the implicit stock of capital (K) will be

$$K = I_T + (1 - \delta) K_{-1} \quad (64)$$

Here δ is the – assumed – depreciation rate, $(1/\delta)/4$ is the average lifetime in years of the capital equipment. We assume that the depreciation rate is equal to 2.5% each quarter (or, equivalently, that the average lifetime of capital is 10 years). To use equation (64) for the calculation of a capital stock, we lack an initial capital stock. Some aspects concerning the calculation of capital stock is found in Vetlov (2003), Appendix 2.²² According to this paper, we assume that the initial capital stock in 1994q4 is equal to 23495.99 mill. Lit.

Figure 20 Capital Stock (Constant Prices)



Calculating the stock of capital is the first step in introducing supply effects in the model. Capacity effects (utilisation rate of capital) should at least affect prices, import, and export.

²² Igor Vetlov: “Monetary Transmission Mechanism in Lithuania”. MFD Working Paper 2003 no. 2, Bank of Lithuania.

An estimation of significant supply effects on macro-economic data is, however, difficult and is not included in the current version of the model.

9.5. Profit

We define profit used in the household disposal income as (65); payment from selling the produced goods minus expenses to production factors (commodities (intermediate), labour, and investments).²³

$$Prof = P_Q \cdot Q_T - P_{CT} \cdot C_T \cdot (1 + t_p) - W \cdot t_{ssf} - P_I \cdot I_T \quad (65)$$

Where

$Prof$	Profit ($PROF$, mill. Litas current prices)
Q_T	Production (QRT , mill. Litas constant prices)
P_Q	Producer price (pq , 1995=1)
C_T	Input in sectors ($INRT$, mill. Litas constant prices)
P_{CT}	Price on input ($pint$, 1995=1)
t_p	Net tax rate on products (tp)
W	Wage sum ($Wsum$, mill. Litas current prices)
t_{ssf}	SSF rate (ssc)
I_T	Investments in sectors (IRT , mill. Litas constant prices)
P_I	Price on investments (pi , 1995=1)

9.6. Labour Supply

Labour supply (or the labour force) could be defined as the difference between total population and the inactive population, where the inactive population covers daytime pupils and students, housewives, retired non-working population, the disabled, persons in prisons, and other inactive inhabitants.

On the other hand, it is clear that the labourforce is influenced by the same factors as the population. These factors are a natural increase in population, net-migration and administrative-territorial changes. The main factor influencing net-migration and labour market participation is the real average wage in private sectors (w). As in the section for labour demand, we include a dummy for the population census effect (lagged two years).

Besides net wage for private sectors, we have tested the inclusion of other influencing factors, namely, the ratio of gross value added to the World GDP growth index and the unemployment rate, but estimations were not statistically significant. We include population in the left-hand-side of the equations, which means that we estimate the ratio of labour supply to the total population rather than the labour supply itself. The specified long and short-run equations for labour supply are respectively:

²³ We could choose to include profit from private sectors only, and that profit from the public sector (S_4) is governmental income.

$$\log(L_S^*) = \alpha_0 + \log(POP) + \alpha_1 \log(w/P_C) + \alpha_2 D_{PC,-8} + \alpha_3 \log(Y/Y_{World}) + \alpha_4 U \quad (66)$$

$$\begin{aligned} \text{Dlog}(L_S) = & \text{Dlog}(POP) - \beta_0 (\log(L_{S,-1}^*) - \log(L_{S,-1})) \\ & + \beta_1 \text{Dlog}(w/P_C) + \alpha_3 D_{PC,-8} + \beta_3 \text{Dlog}(Y/Y_{World}) + \beta_4 D(U) \end{aligned} \quad (67)$$

Where

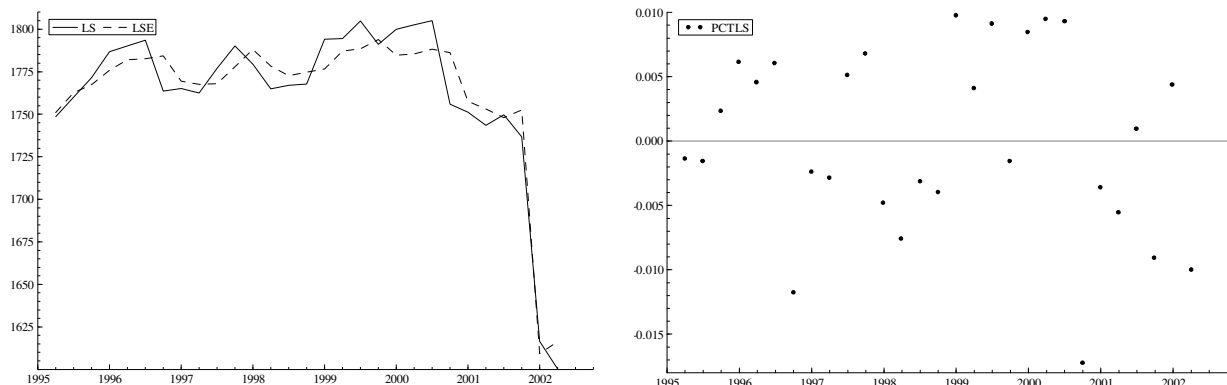
L_S	Labour force (L_S , 1000 persons)
L_S^*	Labour force equilibrium level
POP	Population (POP , 1000 persons)
W	After tax wage in private sector ²⁴
P_C	Consumer price (p_c , 1995=1)
Y	Total gross value added ($GDPT$, mill. Litas in constant prices)
Y_{World}	World GDP index (GDP_{wr} , 1995=1)
U	Unemployment rate
D_{PC}	Dummy for population census (1 from 2000q1)

Table 15 Labour Supply, Parameter Estimates

Param	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_3	β_4
	-1.138	0.070	-0.081	0	0	0.439	0	0	0
	[-7.44]	[2.93]	[-10.7]	*	*	[3.13]	*	*	*
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.800235$									

As seen from Table 15 in the chosen estimation, parameters to the additional variables are restricted to zero. There is a small positive effect of the real wage, implying that increasing wages increases the labour market participation rate of the population.

Figure 21 Labour Supply, Fit and Residuals



²⁴ After tax wage is calculated as $w = nt_{\min} + (w_{PRI} - nt_{\min}) \cdot (1 - t_L)$, see Section 3.2.

10. Prices and Wages

The general idea in the price equations is that producer prices in the different sectors are determined (mainly) by the production costs, and prices on final consumption (private and public consumption, investments, and export) are determined by weighting the prices on deliveries from the different sectors and abroad by using input-output coefficients (or estimated weights).

10.1. Producer Prices

We assume that producers maximise profit. In the long-run (in equilibrium), the output price in sectors (P_Q) equals the marginal costs with a mark-up, and since we assume constant return to scale, the marginal costs are equal to the equilibrium unit costs to commodities, labour, and investments.²⁵ The unit cost (\bar{P}) can be calculated as (68). The variables are explained below (71).

$$\bar{P}_{Q_j} = \left[(1+t_p) \cdot P_{C_j} \cdot C_j + (1+ssc) \cdot w \cdot L_j + P_I \cdot I_j \right] / Q_j \quad (68)$$

Furthermore, we estimate a constant (positive) mark-up (μ_j); if competition is perfect, there will be no mark-up. With a constant mark-up on unit costs, we have the following equilibrium output price (P^*):

$$P_{Q_j}^* = (1+\mu_j) \cdot \bar{P}_{Q_j} \Leftrightarrow \log(P_{Q_j}^*) = \alpha_{0j} + \log(\bar{P}_{Q_j}) \quad (69)$$

Besides unit cost, the producer price could also depend on the import price (P_M). A reason for including the import price could be to model the degree of price-taking in markets where domestic producers compete with foreign companies. This is done in the first version of LITMOD for some sectors. The export price (or World Market Price) could be included as an explanatory variable in sectors with a large amount of export.

Allowing dependence on import price, time-varying mark-up, and quarterly dummies (because the seasonal fluctuation can be different in the explanatory variables and the dependent variable), we extend (69) to (70):

$$\begin{aligned} \log(P_{Q_j}^*) = & \alpha_{0j} + \alpha_{2j} \cdot t + \lambda_{2j} \cdot Q_2 + \lambda_{3j} \cdot Q_3 + \lambda_{4j} \cdot Q_4 \\ & + \alpha_{1j} \cdot \log(\bar{P}_{Q_j}) + (1-\alpha_{1j}) \cdot \log(P_M) \end{aligned} \quad (70)$$

The price equations are homogenous in prices, i.e., output prices are in the long-run increased by 1% if the import price and all the factor prices (PC_j , w , and P_I) are increased by 1%.

We estimate an error correction to the equilibrium price and explain changes in the output price with changes in the unit costs (\bar{P}_Q) and changes in import price (P_M). In the short-run, we do not impose price homogeneity.

²⁵ In this equation, we use the investment costs each quarter, but the companies' cost of having capital should be calculated as user-cost on the capital stock. Capital is financed by loans and the interest rate would affect the companies' cost of having the capital stock.

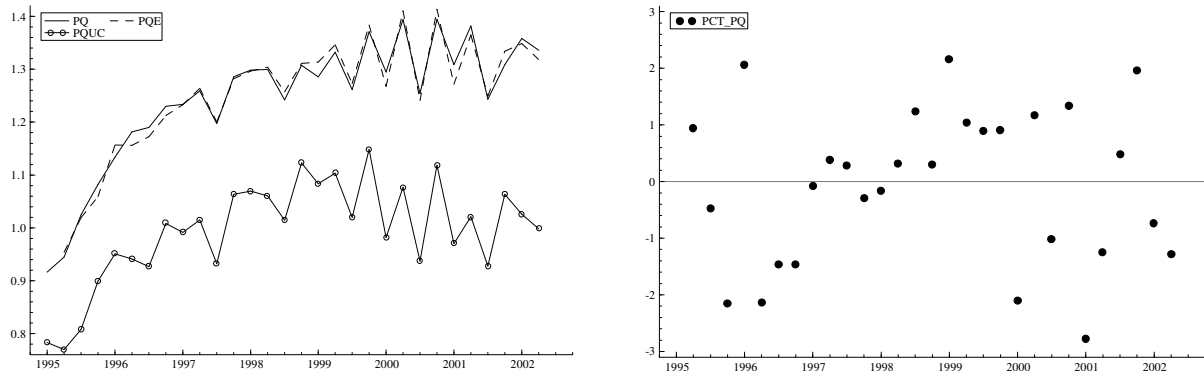
$$\begin{aligned} \text{Dlog}(P_{Qj}) = & \beta_{0j} \left[\log(P_{Qj}^*) - \log(P_{Qj}) \right] \\ & + \beta_{1j} \cdot \text{Dlog}(\bar{P}_{Qj}) + \beta_{4j} \cdot \text{Dlog}(P_M) \end{aligned} \quad (71)$$

Where

P_{Qj}	Producer price in sector j (PQj , 1995=1)
P_{Qj}^*	Producer price in sector j , equilibrium level
\bar{P}_{Qj}	Unit costs in sector j , ($PQUCj$)
Q_j	Production in sector j (QRj , mill. Litas constant prices)
C_j	Intermediate in sector j ($INRj$, mill. Litas constant prices)
P_{Cj}	Price on intermediate in sector j ($PINj$, 1995=1)
t_p	Average net tax rate on products ($tp = 0.025$)
L_j	Labour in sector j (LNj)
W	Wage ($WPRI$ in private sectors and $WPUB$ in public sector, monthly wage in Litas)
ssc	Social Security Fund contribution rate ($ssc = 0.33$)
I_j	Investments in sector j (IRj , mill. Litas constant prices)
P_I	Price on investments (PI , 1995=1)

Figure 22 shows the average producer price and the average unit cost ($PQUC$). The figure indicates that the producer price depends on the calculated unit cost with an additional mark-up. The estimated equation has, in most sectors, a high degree of explanation and, as seen in the figure, the estimated producer price (label E) is close to the actual producer price. In general, there is a speedy adjustment towards the long-run producer price, and the average error correction parameter (β_0) is 0.7. The average estimated weight to the import price is in the long-run 0.3 ($1-\alpha_1$) and only 0.04 in the short-run (β_4).

Figure 22 Aggregated Price on Production: Actual, Estimated and Residuals



10.2. Price on Intermediate

In a standard Input-Output modelling framework, the intermediate used in sector j (C_j) is a constant share of production in sector j where the share is given by the sum of I-O coefficients a_{ij} (deliveries from sector i to sector j).

$$C_j = Q_j \cdot \sum_i a_{ij} \quad (72)$$

The prices on intermediate (PC_j) should then be calculated as a weighted sum of the prices on deliveries, i.e., the producer prices in the delivering sectors (PQ_i) (73). The weights are the share of intermediate in sector j that comes from sector i ; this is the input-output coefficient of deliveries from sector i to sector j divided by the sum of the input-output coefficients of deliveries from all sectors to sector j .

$$P_{C_j}^* = \sum_i \left(\frac{a_{ij}}{\sum_l a_{lj}} \right) \cdot P_{Q_i} \quad (73)$$

Where

C_j	Intermediate in sector j (INR_j , mill. Litas constant prices)
Q_j	Production in sector j (QR_j , mill. Litas constant prices)
PC_j	Price on intermediate in sector j (PIN_j , 1995=1)
PQ_i	Producer price in sector i (PQ_i , 1995=1)
a_{ij}	Input-output coefficient, deliveries from sector i to sector j (aij)

This formulation of the intermediate prices does not fit the actual prices very well. In the sectors' determination of intermediate, we had to extend the I-O equation and included a constant term, a linear trend, and quarterly dummies (see Section 8.2). Therefore, we estimate the following price equation for the use of intermediate in sectors. Since part of the intermediate is imported, we also tried to include the import price (P_M) as an explanatory variable, but the import price was not significant.

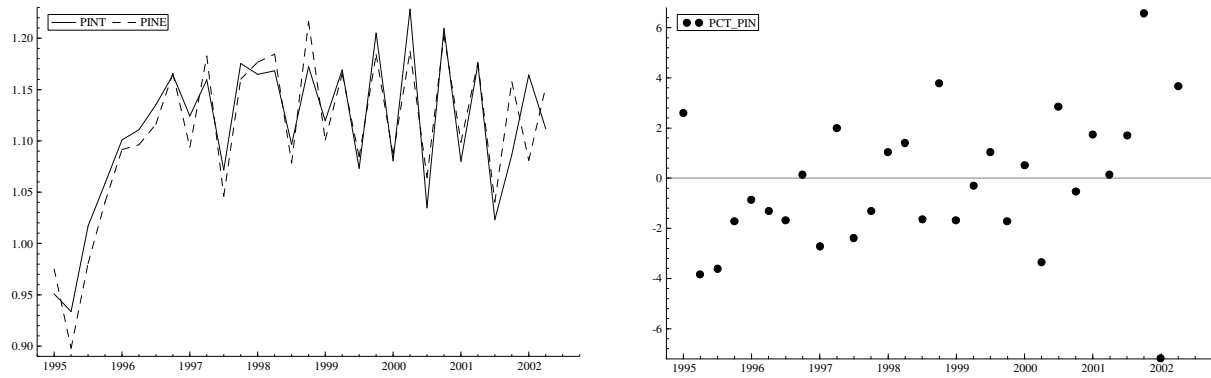
$$\log(P_{C_j}) = \alpha_{0j} + \alpha_{1j} \cdot \log(P_{C_j}^*) + \alpha_{2j} \cdot t + \lambda_{2j} \cdot Q_2 + \lambda_{3j} \cdot Q_3 + \lambda_{4j} \cdot Q_4 \quad (74)$$

We restrict the effect of the I-O determined intermediate price (P_C^*) to unity ($\alpha_{1j} = 1$), i.e., the price equations are homogenous meaning that, if all producer-prices are increased by 1%, then all prices on intermediate are increased by 1%.²⁶

As shown in Figure 23, even though some sectors have large residuals, the overall fit is acceptable.

²⁶ However, in the construction sector (C), we estimate α_1 below one in order to reduce the impact on the intermediate price of the huge fluctuations in the weighted producer prices.

Figure 23 Aggregated Price on Intermediate: Actual, Estimated and Residuals



10.3. Price on GVA

In order to calculate GVA (Gross Value Added) in current prices, we need a price index for aggregated GVA. By definition, GVA is equal to production minus intermediate consumption in constant and current prices. This gives the definition of the GVA price index in (75).

$$Y_v = Y \cdot P_Y = Q_v - C_v \Leftrightarrow P_Y = (Q_v - C_v) / Y \quad (75)$$

Where

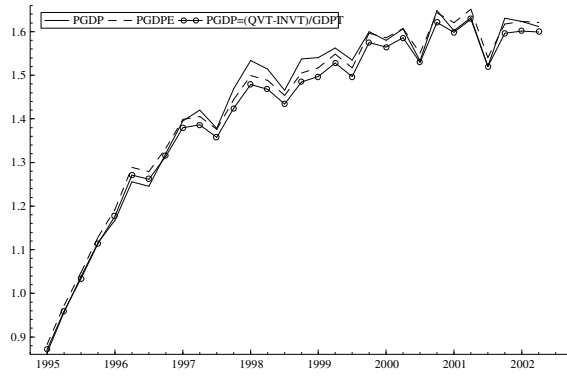
Y_v	GVA ($GDPVT$, mill. Litas current prices)
Y	GVA ($GDPT$, mill. Litas constant prices)
P_Y	GVA price index ($PGDP$, 1995=1)
Q_v	Domestic production (QVT , mill. Litas current prices)
C_v	Intermediate ($INVT$, mill. Litas current prices)

Unfortunately, as shown in Figure 24, this calculated price index is for most of the estimation period somewhat smaller than the actual price index. We, therefore, introduce the simple estimation in (76).

$$P_Y = \alpha_1 \cdot (Q_v - C_v) / Y \quad (76)$$

The parameter α_1 is estimated to 1.01368 with a standard error of 0.00243775.

Figure 24 Price on GVA



10.4. Consumer Price

The price on private consumption is determined by prices on the different goods and services delivered to private consumption. The goods and services are deliveries from different sectors and import, so the determining prices are the producer prices in sectors, as well as import price. The weights should be the share of private consumption delivered from the different sectors and from import. Thus, using input-output coefficients as weights, we have (77) where the a 's are totalling unity. The consumer price is inclusive VAT, so we add VAT to the I-O calculated price:

$$P_C^{I-O} = (1 + t_{vat}) \cdot \left[\sum_i a_{i,Cp} \cdot P_{Qi} + a_{M,Cp} \cdot P_M \right] \quad (77)$$

Where

P_C	Consumer price index (PC , 1995=1)
P_M	Import price (PM , 1995=1)
P_{Qi}	Producer price in sector i (PQi , 1995=1)
t_{vat}	VAT rate ($vat = 0.18$)
$a_{i,Cp}$	I-O coefficient for deliveries from sector i to private consumption ($aicp$)

Unfortunately, we do not have data in the input-output table for deliveries of import to private consumption – only total supply from domestic production and import. We, therefore, use estimated weights instead.

We tried to estimate weights to both the import price and the producer prices in four aggregated sectors (not all 12 sectors – only agriculture (PQA), energy (PQE), aggregated manufacturing (PQM) and aggregated service (PQS)).²⁷ The equation is formulated in logs. The dynamic adjustment is an error correction and the short-term weights are allowed to

²⁷ We also tried to use a calculated domestic price index ($pqcp$) as explanatory variable where the weights are the I-O coefficients of deliveries to private consumption. However, the chosen estimated equation gives a better explanation of the consumer price.

$pqcp = aAcp \cdot pqA + aMNcp \cdot pqMN + aEcp \cdot pqE + aM1cp \cdot pqM1 + aM2cp \cdot pqM2 + aM3cp \cdot pqM3 + aM4cp \cdot pqM4 + aCcp \cdot pqC + aS1cp \cdot pqS1 + aS2cp \cdot pqS2 + aS3cp \cdot pqS3 + aS4cp \cdot pqS4$

differ from the long run weights. The weights add to one, implying that the price equation is static (and dynamic) homogeneous. Furthermore, we include an intercept and quarterly dummies. The quarterly dummies adjust for different fluctuations in the different prices.

$$\begin{aligned}\log(P_C^*) &= \alpha_0 + \alpha_1 \log(P_{Q_A}) + \alpha_2 \log(P_{Q_E}) + \alpha_3 \log(P_{Q_M}) + \alpha_4 \log(P_{Q_S}) \\ &\quad + (1 - \alpha_1 - \alpha_2 - \alpha_3 - \alpha_4) \log(P_M) \\ &\quad + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 + \log(1 + t_{vat})\end{aligned}\quad (78)$$

$$\begin{aligned}D\log(P_C) &= \beta_1 D\log(P_{Q_A}) + \beta_2 D\log(P_{Q_E}) + \beta_3 D\log(P_{Q_M}) + \beta_4 D\log(P_{Q_S}) \\ &\quad + (1 - \beta_1 - \beta_2 - \beta_3 - \beta_4) D\log(P_M) + D\log(1 + t_{vat}) \\ &\quad + \beta_0 [\log(P_{C,-1}) - \log(P_C^*)]\end{aligned}\quad (79)$$

where the additional variables are:

P_C^* Consumer price index, equilibrium level

P_{Qj} Producer price in sector j (P_{Qj} , A, E, M=M1+M2+M3+M4, S=S1+S2+S3+S4)

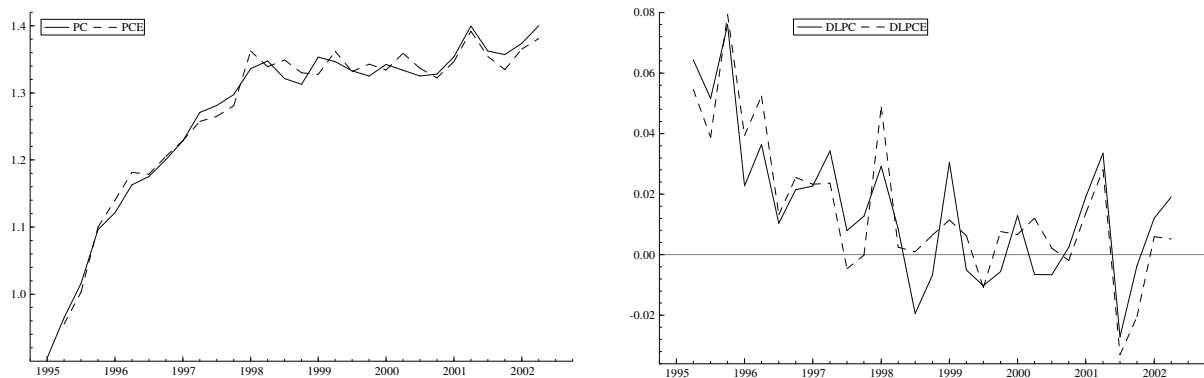
The estimated weights to the output price in sector A, E, and M are negative and insignificant (both in the long and short-term relation) and are, therefore, restricted to zero in the estimation in Table 16, i.e., the consumer price depends on the output price in the service sector and the price on import only.

Table 16 Parameter Estimates, Consumer Price Index

Par.	α_0	α_1	α_2	α_3	α_4	λ_2	λ_3	λ_4	β_0	β_1	β_2	β_3	β_4
	-0.197	0	0	0	0.748	0.031	-0.015	0.063	-0.412	0	0	0	0.820
	[-7.31]	*	*	*	[16.3]	[1.20]	[-0.86]	[1.61]	[-2.30]	*	*	*	[8.85]
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.762$													

The consumer price is both in the short and long-run mostly determined by the producer-price in the service sector ($\alpha_4 = 0.75$ and $\beta_4 = 0.82$), and has a small effect from the import price. The estimated equation fits the actual consumer price reasonably well as seen in Figure 25.

Figure 25 Consumer Price, Actual and Fitted (label E), PC (left) and $D\log(PC)$ (right)



10.5. Price of Public Consumption

The government consumption is produced by the public sector (S4) so the price on government consumption (P_{Cg}) is determined by the producer-price in the public sector ($P_{Q_{S4}}$). We restrict the long-run effect from the public sector producer price to be equal to one ($\alpha_1 = 1$)²⁸ so that the price equation is homogenous. As for the consumer price, we add an intercept and quarterly dummies. We formulate an error correction model (81) because there is autocorrelation in the residuals from an estimation of the long-term equation (80).

$$\log(P_{Cg}^*) = \alpha_0 + \alpha_1 \log(P_{Q_{S4}}) + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (80)$$

$$D\log(P_{Cg}) = \beta_0 [\log(P_{Cg,-1}) - \log(P_{Cg,-1}^*)] + \beta_1 D\log(P_{Q_{S4}}) \quad (81)$$

Where

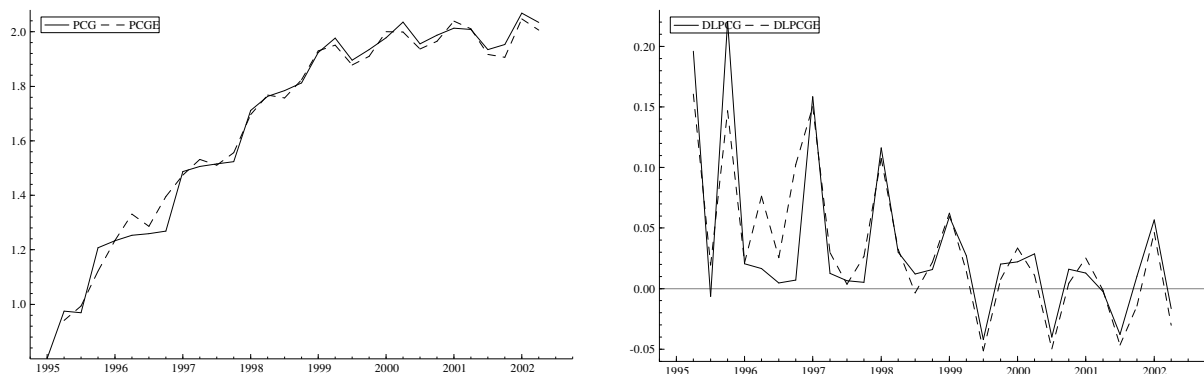
P_{Cg}	Price index on governmental consumption (PCG)
P_{Cg}^*	Price index on governmental consumption, equilibrium level
$P_{Q_{S4}}$	Producer price in public sector S4 ($P_{Q_{S4}}$)

Table 17 Parameter Estimates, Price on Public Consumption

Parameter	α_0	α_1	λ_2	λ_3	λ_4	β_0	β_1
	0.053328	1	-0.034873	-0.005643	0.032378	-0.692816	0.572630
	[2.94]	*	[-1.31]	[-0.23]	[1.20]	[-4.74]	[5.25]
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.788784$							

In the short-run, a 1% increase in the producer price only changes the government consumption price with 0.57% (β_1), but the adaptation towards the long-run price homogeneity is quick ($\beta_0 = -0.69$). As expected, the explanation is good.

Figure 26 Price on Public Consumption, Actual and Fitted



²⁸ α_1 is estimated to 1.04.

10.6. Investment Price

Investments are mainly composed of machinery (domestic production in sector M2 and import) and buildings (domestic production in the construction sector C), so the investment price is modelled as a weighted average of the domestic producer price in the two relevant sectors (PQ_{M2} and PQ_C) and the import price (P_M). We use an error correction equation where the weights are allowed to differ from the long-run equation. The weights add to unity so the price equation is both static and dynamic homogenous. We also try to include an effect of the interest rate.²⁹ There is no need for seasonal dummies in this equation.

$$\log(P_I^*) = \alpha_0 + \alpha_1 \log(P_{Q_{M2}}) + \alpha_2 \log(P_{Q_C}) + (1 - \alpha_1 - \alpha_2) \log(P_M) + \alpha_3 \cdot i \quad (82)$$

$$\begin{aligned} D \log(P_I) = & \beta_0 [\log(P_{I,-1}) - \log(P_{I,-1}^*)] \\ & + \beta_1 D \log(P_{Q_{M2}}) + \beta_2 D \log(P_{Q_C}) + (1 - \beta_1 - \beta_2) D \log(P_M) + \beta_3 D(i) \end{aligned} \quad (83)$$

Where

P_I	Investment price (PI)
P_I^*	Investment price, equilibrium level
P_M	Import price (PM)
$PQ_{M2,C}$	Producer price in sector M2 and C, respectively (PQ_i)
I	Interest rate (ra , %)

The estimated parameters to the producer price in the M2 sector were negative and insignificant and hence restricted to zero ($\alpha_1 = 0$, $\beta_1 = 0$). The long-term estimated weight to the producer price in the construction sector was also negative and insignificant and hence restricted to zero ($\alpha_2 = 0$). The investment price is in the short-run determined by an average of changes in the construction price and changes in the import price ($\beta_2 = 0.54$). In the long-run, only the import price determines the investment price, and there is a small negative effect of the interest rate. However, it does not seem reasonable that the construction price does not have a long-term effect on the investment price. The adjustment is rather slow ($\beta_0 = -0.25$).

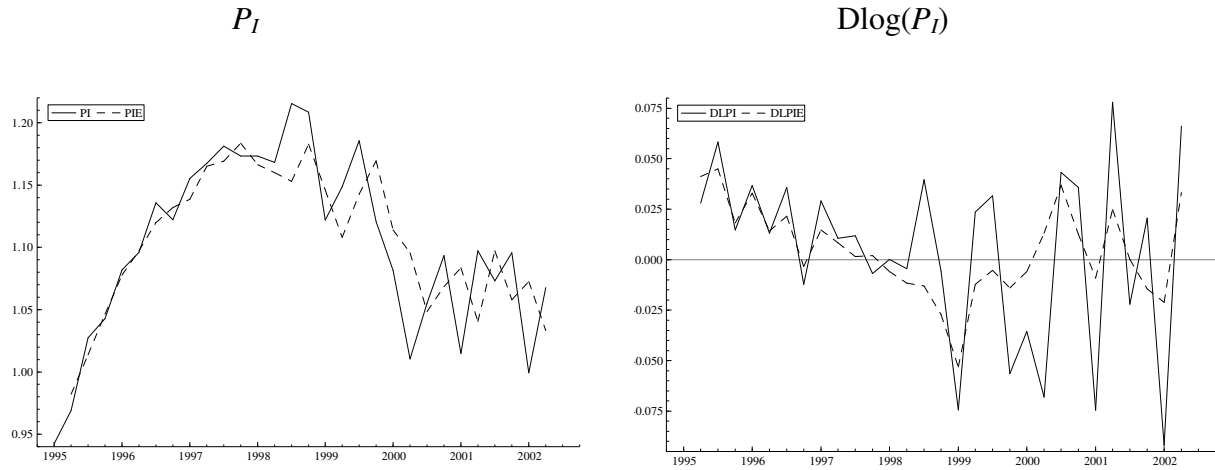
Table 18 Parameter Estimates, Investment Price

Parameter	α_0	α_1	α_2	α_3	β_0	β_1	β_2	β_3
	0.1885	0	0	-0.0063	-0.2531	0	0.5384	0
	[2.51]	*	*	[-1.28]	[-2.10]	*	[2.14]	*
Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.427083$								

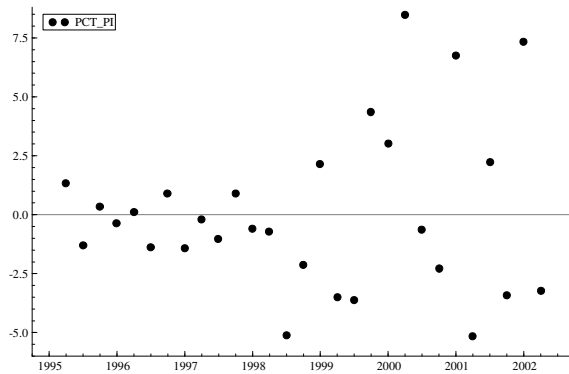
The problem with this estimation is that few of the changes in the investment price is explained by the equation, and as seen in Figure 27, the residuals increases in the last part of the sample period.

²⁹ Since investments are mostly financed by loans, it is more expensive to invest if there is an increase in interest rate, in which case, it is possible that the constructor is willing to lower the price in order to maintain delivery.

Figure 27 Investment Price, Actual and Fitted



Residuals in Percentage



10.7. Export Price

The export price is modelled as a weighted average of the domestic producer price (average of exporting sectors) and the average price in three export markets (EU, CIS, and Central Europe) (84). We tried, without success, to estimate an error correction equation.

$$\log(P_X^*) = \alpha_0 + \alpha_1 \log(P_{Q,export}) + \alpha_2 \log(P_{EU}) + \alpha_3 \log(P_{CI}) + (1 - \alpha_1 - \alpha_2 - \alpha_3) \log(P_{CE}) \quad (84)$$

Where

P_X	Export price (px , 1995=1)
P_X^*	Export price, equilibrium level
$P_{Q,export}$	Producer price on exported goods and services ($pqex$ I-O weighted sum)
$P_{EU,CI,CE}$	‘World Market Price’ (in Litass) in EU, CI, and CE ($pwr<eu,ci,ce>$)

Figure 28 shows the export price and the prices used as explanatory variables. The EU price (corrected for exchange rate) decreases during the estimation period. There has been a steady increase in the Central Europe price, whereas there has been a huge inflation in the CIS countries (dotted line).

Figure 28 Export Price, Domestic Producer Price and Market Prices

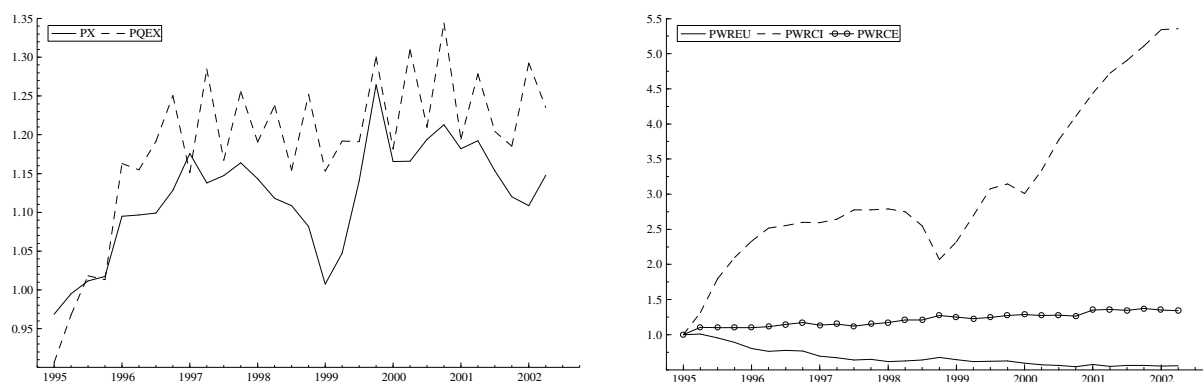


Table 19 shows the estimated coefficients. The equation is not improved by including seasonal dummies.

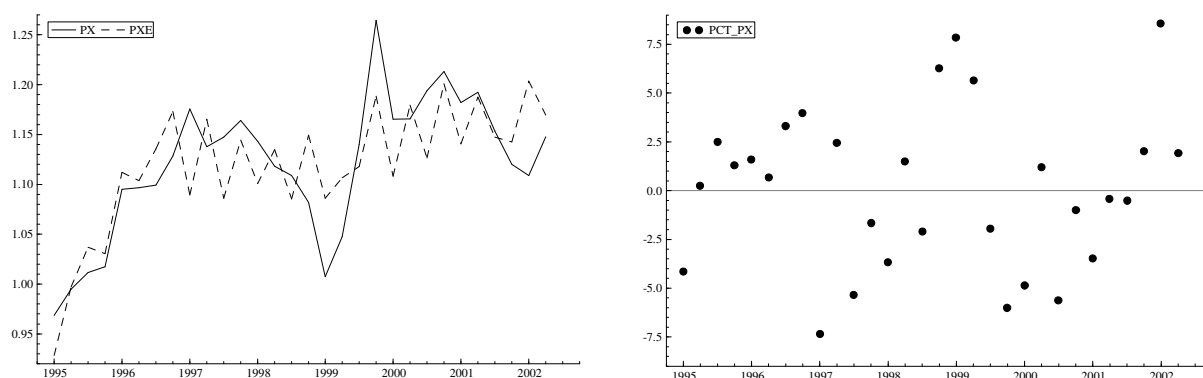
The export price is mostly determined by the domestic producer price ($\alpha_1 = 0.64$). The effect of the CIS price is surprisingly small ($\alpha_3 = 0.05$). Since the export price is not entirely determined by the World Market Price, the export market is not assumed completely competitive (as we saw in the estimation of export in Section 6).

The historical fit of the relation is shown in Figure 29. It shows that the decrease in the export price in the middle of the estimation period cannot be explained by the CIS-price, which was expected.

Table 19 Parameter Estimates, Export Price

Parameter	α_0	α_1	α_2	α_3	$(1-\alpha_1-\alpha_2-\alpha_3)$
	-0.011933	0.635000	0.165707	0.052584	0.146709
	[-0.51]	[5.49]	[2.69]	[1.07]	*
Estimation period 1995q1-2002q2. t-values in []. * Restricted parameter. $R^2 = 0.594405$					

Figure 29 Export Price, Fit of Equation



10.8. Import Price

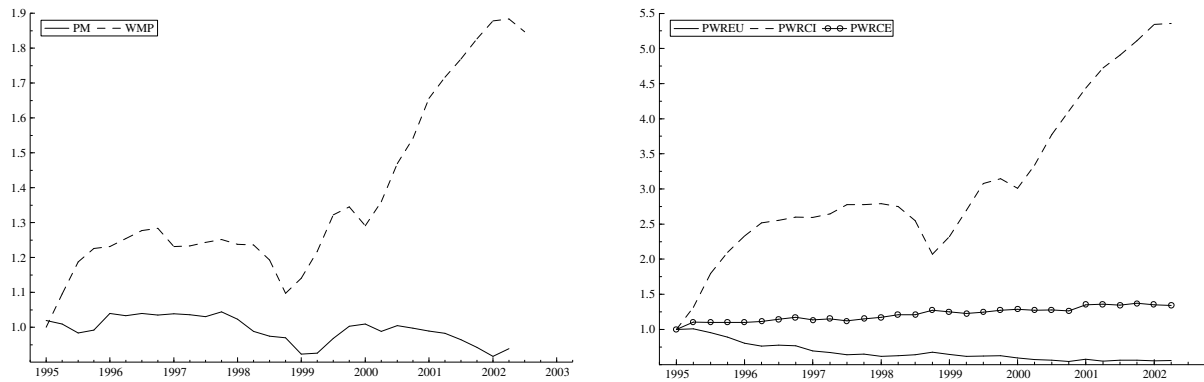
The price of imported goods and services depends on the producer price (in Litass) in the countries where the goods are produced. In the former LITMOD, the import price was

modelled as a weighted average of the prices in the three major import markets (CIS, Central Europe, and EU) and could be thought of as a World Market Price (Equation (85)):

$$\log(p_M) = \alpha_0 + \alpha_1 \log(p_{CE}) + \alpha_2 \log(p_{CI}) + (1 - \alpha_1 - \alpha_2) \log(p_{EU}) \quad (85)$$

Figure 30 (left) shows the import price and the ‘World Market Price’ (*wmp*) used in the export equation, and it is seen that while the World Market Price has grown rapidly, the import price has decreased. In the figure to the right, the three price indexes of EU, CE, and CIS corrected of exchange rate are plotted, and the growth in the World Market Price comes from the growth in the CIS price index.

Figure 30 Import Price and World Market Prices



We were not able to estimate a reasonable equation. Therefore, we choose to treat the import price as an exogenous variable. It could, for instance, be updated with the same growth rate as the World Market Price.

The import price is a very important exogenous variable in the model, e.g., in the price determination.

10.9. Wages

Concerning wages, we have time series for the average monthly gross earnings for fulltime workers in the private and the public sector.

From the neoclassical theory, we have in the long-term, real wage changes depending on changes in labour productivity. According to the Phillip’s curve theory, real wages are mainly determined by the unemployment rate or nominal wages depending on unemployment and inflation. From theories concerning wage negotiations, we also have the bargaining power of employees depending on unemployment and changes in labour productivity. This means that we have, in the long-term, a wage equation such as (86). If the neoclassical theory is dominant, the coefficients α_1 and α_2 should equal one and α_3 should equal zero. If the Phillip’s curve theory is dominant, α_1 should be insignificant. Finally, if wages are not fully compensated for inflation, α_2 should be between 0.0 and 1.0.

The long-run wage equation states that the private sector wage (w_{PRI}) is related positively to the labour productivity (Y/L), and negatively related to the unemployment rate (U). We include the social security contribution rate at the right-hand side of both equations, because it forms part of the labour cost, i.e., any changes in this variable will obviously influence

production cost and the dynamics of the private sector wage. We include quarterly dummies since wage is probably more stable during the year than the explanatory variables (consumer price and time productivity). We formulate an error correction model (87), but we were not able to estimate any short-term effect on changes in the explanatory variables, apart from a consumer price effect. The parameter estimates are shown in Table 20, and Figure 31 shows that the estimated equation (label E) catches most of the changes in the wage.

$$\log(w_{PRI}^*) = \alpha_0 - \log(1 + ssc) + \alpha_1 \log(Y/L) + \alpha_2 \log(P_C) + \alpha_3 U + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (86)$$

$$D \log(w_{PRI}) = \beta_0 \left[\log(w_{PRI}^*)_{-1} - \log(w_{PRI})_{-1} \right] - \log((1 + ssc)/(1 + ssc)_{-1}) + \beta_1 D \log(Y/L) + \beta_2 D \log(P_C) + \beta_3 D(U - U_{-1}) \quad (87)$$

Where

w_{PRI}	Average monthly gross earnings in the private sector (w_{pri} , Litas)
w_{PRI}^*	Wage, equilibrium level
ssc	Social security fund contribution rate
Y	GDP in private sector (GDP_{pri} , mill. Litas constant prices)
L	Labour in private sector (LN_{pri} , 1000 full time employed)
P_C	Price deflator on private consumption (pc , 1995=1)
U	Unemployment rate (U , rate)
Q_2 - Q_4	Quarterly dummies; Q_2 is equal to one in second quarter and else zero

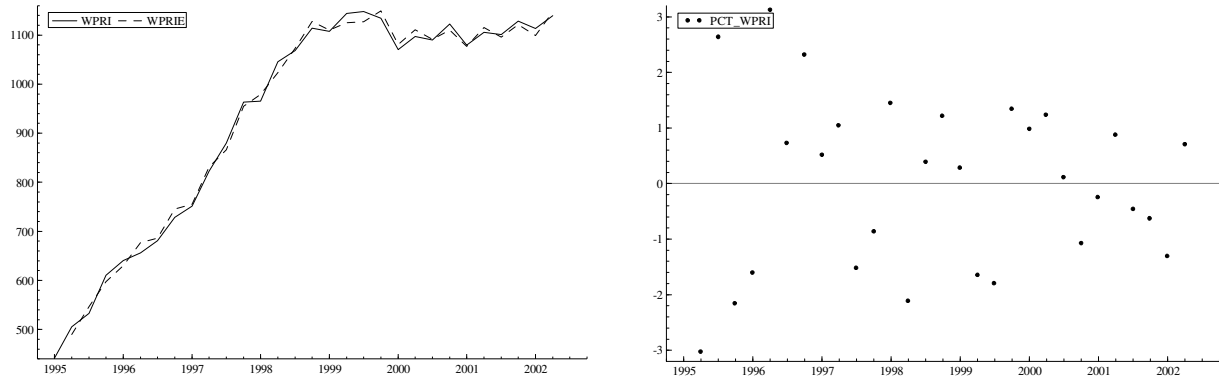
In the long-run, a productivity increase of 1% increases the wage with 0.84% ($\alpha_1=0.84$). The effect of the unemployment rate is very high; if unemployment increases from, e.g., 8% to 9%, wage decreases with 5% in the long-run.³⁰ This large effect of unemployment is mainly determined by the last part of the estimation period where we have an increasing productivity, increasing unemployment, and an almost unchanged real wage (see Figure 32 right-hand side). The adjustment to equilibrium is rather slow ($\beta_0 = 0.2$), but statistically significant.

Table 20 Parameter Estimates, Private Wage

Parameter	α_0	α_1	α_2	α_3	β_0	β_1	β_2	β_3	λ_2	λ_3	λ_4
	5.899	.8404	1	-5.361	.2091	0	.3336	0	-.225	-.239	-.383
	[16.05]	[4.636]	*	[-3.810]	[4.937]	*	[1.369]	*	[-4.111]	[-3.347]	[-4.362]
Estimation period 1995q2-2002q2; t-values in [];* restricted parameter; $R^2=0.883812$											

³⁰ However, compared with other studies of wage determination, this is not unreasonable in an estimation on macro time series [Carnot 2002].

Figure 31 Wage in the Private Sector, Fit of Estimated Equation (left: log, right Dlog)



The public sector wage (w_{PUB}) follows the private sector wage. Figure 32 (left) shows that the equation underestimates the public wage for the last years. There is no need to specify a dynamic adjustment, but we correct for autocorrelation in the equation.

$$\log(w_{PUB}) = \alpha_0 + \log(w_{PRI}) + \rho [\log(w_{PUB})_{-1} - \alpha_0 - \log(w_{PRI})_{-1}] \quad (88)$$

Where

w_{PUB} Average monthly gross earnings in the public sector (w_{pub} , Litas)

w_{PRI} Average monthly gross earnings in the private sector (w_{pri} , Litas)

Figure 32 Wage in the Public Sector, Fit Estimated Equation

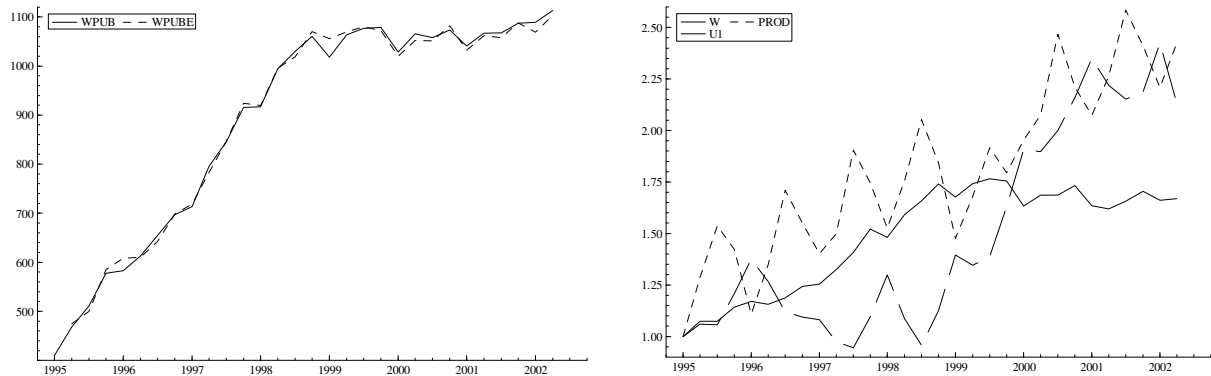


Table 21 Parameter Estimates, Public Wage

Parameter	α_0	ρ
	-.045328	.571123
	[-6.85622]	[3.63001]
Estimation period 1995q2-2002q2; t-values in []; $R^2 = 0.997$		

The wages are average monthly wages in Litas per full-time worker, and L is 1000 fulltime workers, so we calculate total quarterly wage amount in mill. Litas as:

$$W_{SUM} = 0.001 \cdot 3 \cdot w_{PRI} \cdot L_{PRI} + 0.001 \cdot 3 \cdot w_{PUB} \cdot L_{PUB} \quad (89)$$

11. Model and Scenarios

We described in the previous chapter the different parts of the model, and we will in this last chapter explain how the model can be simulated as well as how a baseline scenario is constructed. We will also show some simulation experiments with the model.

All the equations in the model are estimated using the software TSP and the model is simulated in the same software.

11.1. Solving the Model

Large economical models currently used for forecasting and simulations are typically both highly simultaneous and non-linear. Even simple macro-economic models, where all the stochastic equations in the system may be linear in logarithms, include accounting identities that are linear in levels. As a consequence, although a model may be estimated using linear techniques, forecasts with that model (which need to take into account identities) will normally involve using non-linear solution techniques. The present Lithuanian macro-econometric model is not an exception from this rule.

In general, it is commonly agreed that non-linear models cannot be solved analytically or that the solution is quite impractical. Therefore, common practice is to resort to numerical algorithm for model solving.

Simulating models, of the two main categories of algorithms, the Newton and the Gauss-Seidel methods,³¹ the Gauss-Seidel method has been almost universally adopted for solving large models. However, a non-linear model could, in general, exhibit multiple solutions. So when the Gauss-Seidel method is used for model solution, care must be taken to ensure that the solution is either unique or that the model is converging on a ‘desired’ solution.

In this section, we briefly outline the Gauss-Seidel technique and discuss some possible problems caused by the method. Afterwards, we present the ex-post solutions of the model calculated by this technique and we investigate the simulation results.

11.1.1. The Gauss-Seidel Solution Technique

A general dynamic n equation non-linear model could be written in the following implicit form:

$$f(y_t, Y_{t-1}, X_t, u_t; \theta) = 0 \quad (90)$$

where

f	$n \times 1$ vector of valued functions
y_t	$n \times 1$ vector of endogenous variables
Y_{t-1}	$n \times (p-1)$ matrix of lagged endogenous variables (with a maximum lag order p)
X_{t-1}	$n \times q$ matrix of current and lagged values of exogenous variables

³¹ In the TSP software, the Newton and the Gauss-Seidel methods correspond to the commands SIML and SOLVE, respectively.

u_t $n \times 1$ vector of residuals
 θ vector of parameters

As mentioned above, it is agreed that for non-linear models, an analytic solution of (90) does not exist, i.e., the corresponding reduced form of (90), i.e. equation (91) has to be found using iterative numerical methods (Gauss-Seidel in our case).

$$y_t = g(Y_{t-1}, X_t, u_t; \theta) \quad (91)$$

So, as the first step, the Gauss-Seidel method requires (90) to be normalised, i.e., it should be represented in the explicit form:

$$y_{t,i} = h_i(y_{t,-i}, Y_{t-1}, X_t, u_t; \theta), i = 1, \dots, n \quad (92)$$

For example, if we have log-linear (long-term equation) regression, then normalisation means to take exponent on both sides of the equation. In the short-run equation, we first add the logarithm of the lagged endogenous variable to both sides and then take exponent. Each equation in (90) should be normalised on one endogenous variable, but it cannot appear twice in the left side of (92). In general, normalisation is almost always possible, but not unique. Convergence of the iteration procedure will depend on the particular normalisation that has been adopted. This is a recognised disadvantage of the Gauss-Seidel compared with the Newton method. On the other hand, the Newton method requires the inversion of the matrix of model derivatives and is hard to implement in the case of large macro models (more than 25 equations as suggested in the TSP User's Guide). The Jacobi or the Gauss-Seidel methods have no such limitation, but normalisation is the problem.³²

The Gauss-Seidel method proceeds by first assigning starting values to the vector y_t known as initial values. In practice, these are often the actual values of this vector in the previous period (last quarter in our case).

The Gauss-Seidel method solves each of the n equations in the order $i, i = 1, \dots, n$. The number s iteration is

$$y_{it}^s = h_i(y_{1t}^s, \dots, y_{i-1t}^s, y_{i+1t}^{s-1}, \dots, y_{nt}^{s-1}, Y_{t-1}, X_t, u_t; \theta) \quad (93)$$

This method differs from the Jacobi method in that equation i uses the solution from this iteration for all variables defined by equations appearing earlier in the model: i.e., $y_{jt}, j < i$. For this reason, the method is also known as the *method of successive substitution*. This variation on the Jacobi method has been found to considerably speed up convergence.

On the other hand, it makes convergence dependent on the equation ordering. Don and Gallo (1987) suggest an algorithm for the optimal ordering of a system of equations for the Gauss-Seidel model solution. This orders the model equations to maximise the recursivity of the system, which is equivalent to ordering the equations to make the Jacobean matrix as close as possible to being lower triangular.

³² Further discussion of the problem can be found in S.G.Hall and S.G.B. Henry (1989).

The Gauss-Seidel method could also be speeded up by adding relaxation parameter α ($0 < \alpha < 1$) into (93) (*Successive Over Relaxation*, SOR method). The optimal value of α will depend on the model and can be found by experimentation.

The next step in the following discussion will be a brief theoretical analysis of predictions with non-linear models.

As with linear models, ex ante forecasts could be done by using the reduced form (92). We should notice that both static (actual values are used as explanatory variables) and dynamic (previous model solutions are used) solutions are available. In terms of forecasts, the dynamic solution is used. However, in the case of non-linear models, one disadvantage should be mentioned – the solution is not unbiased anymore, i.e.,

$$E\langle y_t | Y_{t-1}, X_t \rangle \neq g(Y_{t-1}, X_t, Eu_t, \theta) \quad (94)$$

Unbiased prediction can instead be obtained by the *stochastic simulation method*. The basic idea of this method is, with the help of the Monte-Carlo method, to generate R repeated solutions of $E\{y_t^r | Y_{t-1}, X_t\}$, where in (93): $Eu_t \rightarrow e_t^r \sim N(0, \Sigma)$, $r = 1, \dots, R$ and Σ is a consistent estimate of $\text{Var}(u_t)$. Then, for sufficient large R , the mean of the replications will approximate the left side of (94). However, this is more difficult and time-consuming than using (92), and we will not try with this large model to perform a stochastic simulation.

11.1.2. LITMOD

LITMOD has approximately 150 structural equations and 50 identities. All structural equations have been normalised so that each endogenous variable appears only once at the left-hand side. Table 33 in Appendix 12.5 shows all the equations formulated in TSP code.

The TSP command MODEL is used to produce a collected model. This TSP command splits the model into 2 recursive and 1 simultaneous block:

Table 22 Block Structure of LITMOD

Block #	# Recursive equations	# Simultaneous equations
1	4	
2		141
3	60	

A quick inspection of the model confirms the following:

- We have four identities in the first recursive block, which directly influence the simultaneous block. The first three identities (real CPI in different groups of countries) only involve exogenous variables and lagged endogenous variables. The fourth equation (the World Market Price) is only dependent on the real CPI's. We can see that this block could be treated as an exogenous flow into LITMOD.
- The equations in the simultaneous block are solved with the Gauss-Seidel method as described earlier. We use a dynamic solution for this block, i.e., previously computed values are taken as the lagged endogenous variables.

- After this block, there are a number of equations that can be solved separately by only using information on exogenous variables and previously solved endogenous variables.
- Recursive blocks are solved in one iteration.
- The convergence of the simultaneous block is rather slow (approximately 50 iterations are needed to solve each period in the simulation period).

The TSP command SOLVE will simulate the model. In the next section, we look at the ex-post solution where the model is simulated in the historical period, and we will afterwards simulate the model for forecast proposes.

11.2. LITMOD Ex-Post Solution

In this section, we verify the accuracy of point predictions produced by LITMOD. All equations are formulated according to the theoretical considerations and estimations discussed earlier in this documentation, and collected in one model (LITMOD). ‘What if’ types of scenarios will be analysed in the Scenarios section below and will reveal additional information about the linkage between different endogenous and exogenous variables. The aim of this section is to compare simultaneous solutions within observation period (ex-post forecasts) against actual values.

We have verified the model performance over the historical period of 1995q4 2002q2, a shorter period than the observation period due to the inclusion of lagged variables in some of the equations.

We have chosen a number of endogenous variables (see Table 23, first column) as the most important output elements and we have used the ACTFIT TSP command, which computes and prints a variety of goodness-of-fit statistics comparing the actual (A) and predicted (P) values of time series. These statistics are: The correlation of the two series (R), the mean square error, the root-mean-square-error (RMSPE), the mean absolute error, the mean percent error (MPE), Theil’s inequality coefficient in first differences ($U\Delta$) and in levels (U), and a decomposition of the source of the discrepancies between the two series. Decomposition is a very important tool for the analysis of short-term predictions, as it explains the source of inequality.³³ In Table 23, we show only some of these statistics.

Besides comparing the simulated and actual values, we also compare the simulated values with the estimated values obtained in the previous sections. The single equation estimation (the ECM fit) minimises the differences between the actual and estimated values. If the model only consisted of single equations with no interactions, the simulated values will equal the ECM fits. So, the differences between the simulated and estimated values show the simultaneity in the model. For example, a systematic error in the disposable income can induce errors in the simulated private consumption.

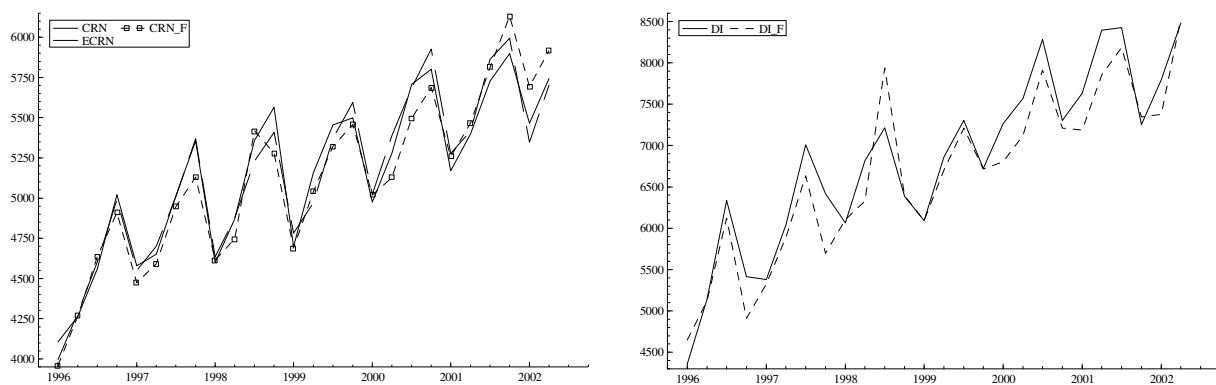
³³ Some theory on short-term forecasts analysis can be found in [Theil, Henri, Applied Economics, North Holland Publishing Company, 1966].

One of the most important endogenous variables is private consumption. Figure 33 (left) shows the actual values of the private consumption (CRN), the simulated values (CRN_F), and the estimated values ($ECRN$).

Being impressively well determined during the separate ECM estimation (see Section 3.3), we have expected the same effect for the private consumption after the simultaneous solution. As seen in Table 23, there is a high correlation between the predicted and actual values ($R = 0.969$) and a small deviation from the actual series ($RMSPE = 2.5\%$). This shows a rather good fit for private consumption. Theil's inequality coefficient in first differences is also relatively small ($U\Delta = 0.3357$), but predicted changes are slightly overestimated. This happens because of overestimation of the first differences of disposable income (DI , Figure 33, right) and unsatisfied short-run prediction of the simultaneously estimated consumer prices (PC , Theil's U in differences is higher than one, see Figure 38, left). On the other hand, both disposable income and consumer prices are reasonably close to the actual series in levels (correlation is correspondingly equal to 0.965 and 0.938) and will due to this produce acceptable long run forecasts.

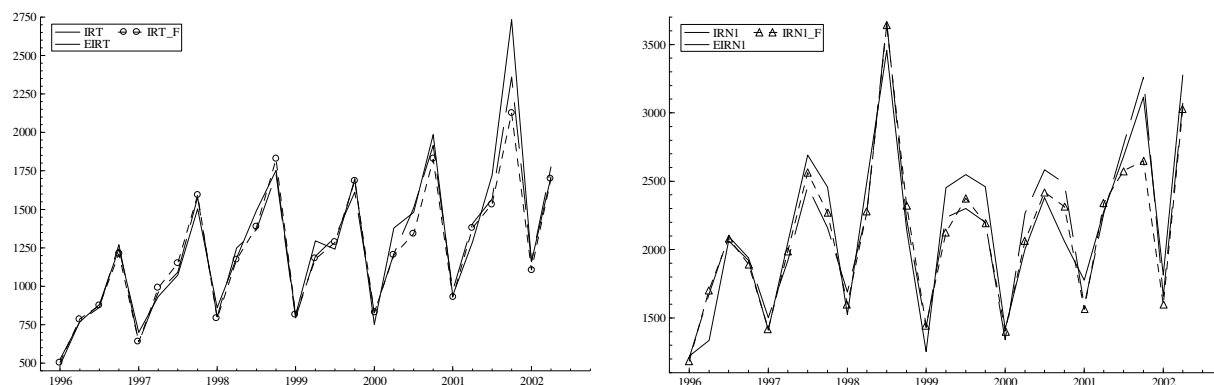
The LITMOD solution for private consumption (CRN_F) is close to the ECM solution ($ECRN$). Disposable income (DI) is influenced by the simultaneous solutions for wages and profits, but despite this, it shows a good performance both in the short and long-run.

Figure 33 LITMOD Solutions: Private Consumption (left), Disposable Income (right)



The most important determinant for the gross domestic investments ($IRNI$) is total capital investments in sectors (IRT). In Figure 34 (left), we see that aggregated total capital investments are reasonably close to the actual series, but percentage changes are getting larger over the estimation period, which leads to an increase in the $RMSPE$ (0.075). However, we should notice that the $RMSPE$ for investments in sectors sometimes approach 0.34, as it was in the ECM solutions. In fact, the simultaneous solution is very close to the ECM results. There were almost no change points in the first differences, but the changes were slightly underestimated. U statistic in first differences is 0.2436, which means that a simultaneous solution in this case provides significant short-run predictions. There is almost the same conclusion for the gross domestic investments.

Figure 34 LITMOD Solutions: Total Capital Investment in Sectors (left), Gross Domestic Investments (right)



Foreign trade is represented in the model by total import (MRN) and export (XRN) of goods and services.

The import has a very low RMSPE of 0.053 and a high correlation with both ECM solution and actual series ensuring good long-run predictions. Short-run performances are underestimated, but significant (U is equal to 0.4107).

Export depends heavily on exogenous variables and hence we would expect the simulated value to be close to the estimated value. The export equation has acceptable long-run properties: small variation (RMSPE 0.08) and high correlation. However, short-run predictions are not acceptable: many turning points are not explained (wrong signs of changes compared to the actual signs of changes) leading to Theil's U coefficient being equal to 0.89, which is in the short-run close to a no-change extrapolation.

Figure 35 LITMOD Solutions: Import (left), Export (right)

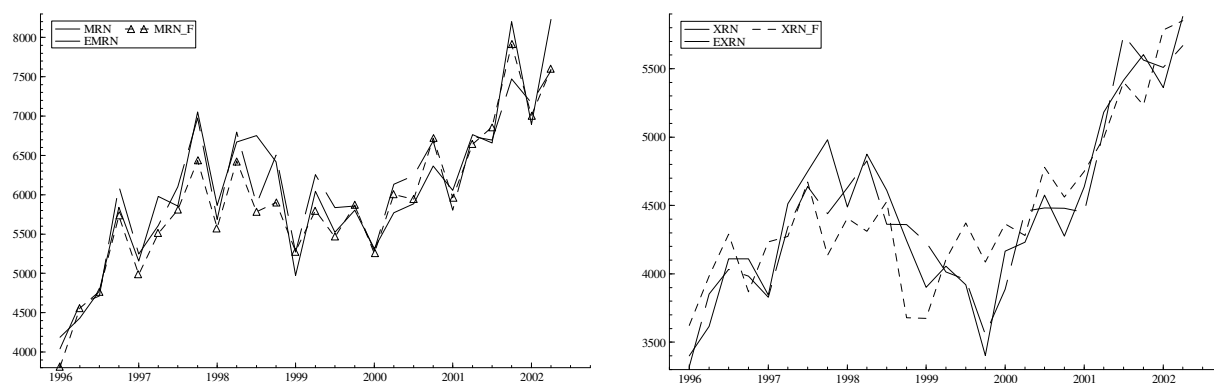
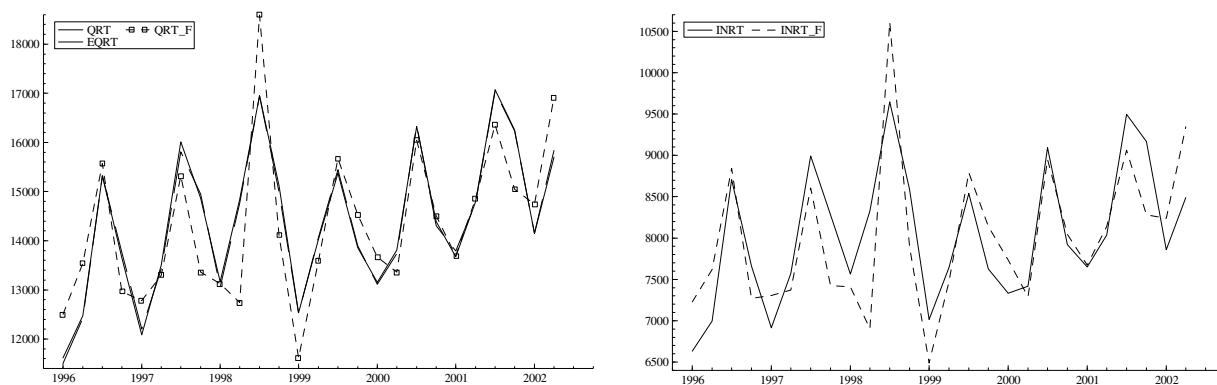


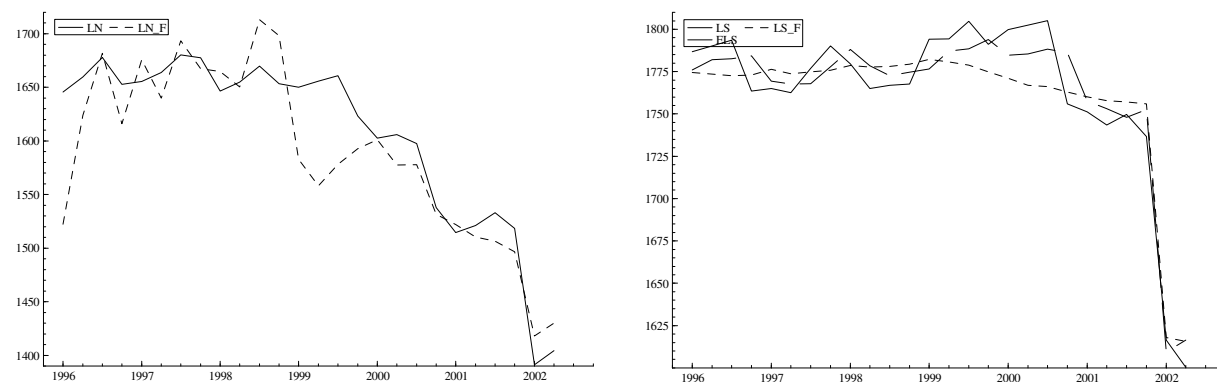
Figure 36 illustrates that total production (QRT), total intermediate ($INRT$), and implicitly total gross value added ($GDPT=QRT-INRT$) has the same form of development over the estimation period. This is due to the fact that they are linked through the Input-Output system. The time series catch the long-run tendency (high correlation 0.83, 0.77, respectively, and small Percent Errors), and short-run changes (U in first differences close to 0.5) quite well, but the first differences are often overestimated.

Figure 36 LITMOD Solutions: Total Production (left), Total Intermediate (right)



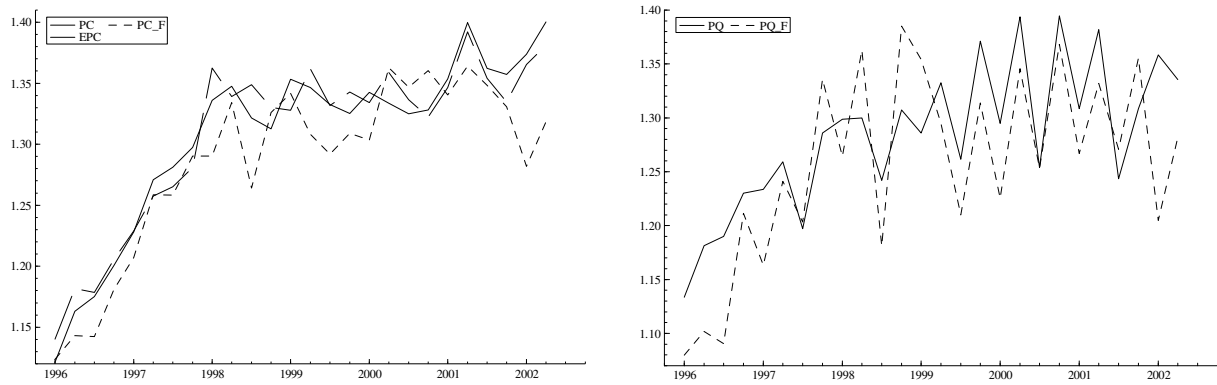
Total labour demand (LN) and labour supply (LS) capture the long-run tendency, but fail to explain short-run changes. Too large changes for total labour demand and a number of turning points lead to U being unacceptably high. In addition, decomposition of U shows that a bias in the first differences. This means that no-change extrapolation in the short-run provides better results in terms of smaller root-mean-square-error. The labour supply is mostly influenced by the exogenous number of population (POP) and is in the long-run also close to a no-change extrapolation.

Figure 37 LITMOD Solutions: Labour Demand (left), Labour Supply (right)



Finally, we examine some price indices. The most important are the consumer price (PC) and the producer price (PQ) indices. As for labour market series, the equations have consistent long-run properties, but (especially in the case of consumer prices) explain short-run changes insufficiently.

Figure 38 LITMOD Solutions: Consumer Price Index (left), Producer Price Index (right)



The mentioned results concerning the accuracy of ex-post simulation of LITMOD are summarised in Table 23.

Table 23 Ex-Post Forecast Verification Results

Variable	Description	R	RMSPE	MPE	p-value	UΔ	U
IRT	Capital investment	0.965	0.076	0.0236	0.0247	0.2436	0.1070
WPRI	Wage	0.980	0.051	0.0386	0.1659	0.9793	0.0547
QRT	Production	0.831	0.059	0.0031	0.0556	0.4993	0.0596
GDPT	Value Added	0.886	0.050	0.0042	0.2000	0.4228	0.0505
INRT	Intermediate	0.779	0.067	0.0019	0.0231	0.5543	0.0685
Prof	Profit	0.926	0.099	0.0078	0.6494	0.4686	0.0909
CRN	Private consumption	0.969	0.025	0.0058	0.0841	0.3357	0.0260
DI	Disposable income	0.965	0.050	0.0244	0.9661	0.4843	0.0500
LN	Labour demand	0.874	0.026	0.0094	0.2120	1.3020	0.0265
LS	Labour supply	0.943	0.009	0.0020	0.2232	0.6028	0.0096
XRN	Export	0.857	0.080	-0.0078	0.6856	0.8899	0.0760
MRN	Import	0.950	0.053	0.0232	0.8157	0.4107	0.0558
CGREV	Gov. revenue	0.988	0.038	0.0326	0.7803	0.5602	0.0385
PQ	Producer price	0.828	0.048	0.0223	0.0005	0.8650	0.0478
PC	Price on consumption	0.938	0.028	0.0174	0.2341	1.1553	0.0282
IRN1	Domestic investments	0.949	0.095	0.0128	0.5557	0.2751	0.0875

In this table:

R Correlation Coefficient, $R = \frac{\frac{1}{n} \sum (P_i - \bar{P})(A_i - \bar{A})}{s_P s_A}$

RMSPE Root-Mean-Squared Percent Error, $RMSPE = \sqrt{\frac{1}{n} \sum \left(\frac{P_i - A_i}{A_i} \right)^2}$

MPE Mean Percentage Error, $MPE = \frac{1}{n} \sum \frac{P_i - A_i}{A_i}$

p-value p-value for test $H_0: \beta=1$ in the regression $P_i = \beta \cdot A_i$

UΔ Theil's U Inequality coefficient (in first differences), $U\Delta = \sqrt{\frac{\sum (\Delta P_i - \Delta A_i)^2}{\sum \Delta A_i^2}}$

U Theil's U Inequality coefficient (in levels), $U = \sqrt{\frac{\sum (P_i - A_i)^2}{\sum A_i^2}}$

High correlation and small deviation of predicted values from actual series confirms that LITMOD, in most cases, produces adequate and reasonable long and medium-term forecasts. Also, most of the equations catch short-run changes reasonably well, but another part of LITMOD shows that the short-run solutions are no better than corresponding simple no-change extrapolations, i.e., one should be very cautious about the quality of short-term point predictions, but be satisfied with the long-term and medium-term performance of LITMOD, i.e. the model satisfies the general goals described in the Preface to this documentation.

11.3. Baseline Scenario

In this section, the aim is to produce a baseline scenario over a period of 20 years. We discuss the exogenous variables in Section 11.3.1, and the baseline scenario is presented in Section 11.3.2.

11.3.1. Exogenous Variables

The model includes a number of exogenous variables, and in order to forecast the endogenous variables, a forecast of the exogenous variables is required (see Appendix 12.1 for the list of variables in the model).

The advantages of using a structural econometric model for forecasting are that the equations are based on economic theory and historical data, and that forecasting of the different variables is consistent. However, in order to obtain a simulation for future periods, we will need to know the values for all the exogenous variables over the forecasted period.

In this section, we will discuss the aspects of forecasting the exogenous variables. Some of the exogenous variables are controlled by the policy-maker (policy variables), e.g., tax rates. Other exogenous variables describe the economy outside Lithuania, e.g., the World Market Price. Following a forecast of all the exogenous variables, the model is simulated whereafter we obtain a forecast of all the endogenous variables. Only changes in the exogenous variables will change the forecast. We change the value of some of the exogenous variables in Section 11.4 in order to see the effect on endogenous variables.

In practice, there is different ways to perform forecasts of exogenous variables. One way is to use official forecasts issued by different Lithuanian governmental and private institutions, for instance, Statistics Lithuania, Bank of Lithuania, Ministry of Finance, Lithuanian Free Market Institute, etc. If we do not have official forecasts, simple forecasts, expert evaluations, Box-Jenkins, or ARIMA models are alternatives:

- Simple forecasts are based on the idea of the decomposition of time series into a macroscopic and a microscopic component. The model-builder will thereafter extrapolate the macroscopic component into the forecasting period.
- Expert consensus paradigm derives from the theory of rational expectations, originated from J.F. Muth in 1961 and later elaborated by R. Lucas and other economists. One of the basic assumptions behind the rational expectations theory is that if a connection has been observed between an economic variable and certain processes in the economy, individuals will use all the information available to them in forming expectations and forecasts. These expert evaluations are very useful in the case of short and medium-term forecasts.

- ARIMA models could be thought of as a sophisticated extrapolation method. They are widely used in financial mathematics and as well as expert forecasts produce good predictions within the short and medium-term forecasting.

We use official forecasts whenever possible. In other cases, we tried to either estimate macroscopic components and make a simple extrapolation, or to make reasonable assumptions about the performance of exogenous time series. Naive no-change assumptions are used in some cases.

The few estimated exogenous variables are forecasted by one of the following two forms using the historical information on the seasonal pattern and a time trend. The estimation results performed over the historical data are summarised in Table 24.

$$\begin{aligned} X_t &= \alpha_0 + \alpha_1 T_t + q_2 Q_2 + q_3 Q_3 + q_4 Q_4 + \eta_t \\ \log(X_t) &= \alpha_0 + \alpha_1 T_t + q_2 Q_2 + q_3 Q_3 + q_4 Q_4 + \eta_t \end{aligned} \quad (95)$$

Where

X_t	Dependent variable (one of the exogenous variables in the model)
T_t	Trend part (linear or logarithmic trend)
Q_2 – Q_4	Seasonal dummies
η_t	Residual

Table 24 Exogenous Variables, Parameter Estimates (OLS method)

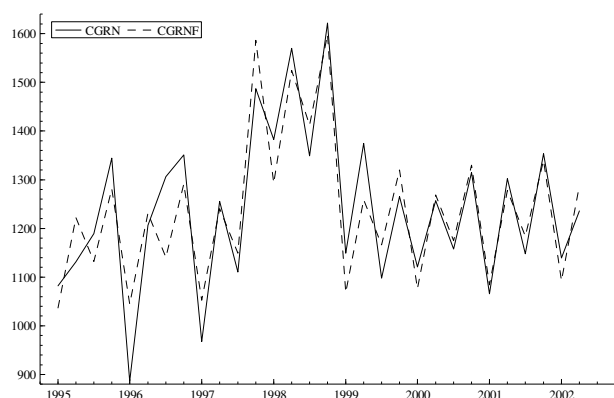
Exogenous variable		α_0	α_1	T_t	q_2	q_3	q_4	R^2
PENSNR 1995q1-2002q4	Number of pensioners	770.74 [51.75]	86.58 [15.60]	log(t)	0 *	0 *	0 *	0.890
CGSEOV 1995q1-2002q4	Non-pension SSSF transfers	34518 [1.13]	82144 [7.18]	log(t)	0 *	0 *	102337 [4.60]	0.736
log(CGRN) ⁻ 1995q1-2002q2	Public consumption	6.94 [215.9]	0.0019 [1.33]	t	0.163 [4.88]	0.084 [2.44]	0.206 [5.91]	0.790
NT 1995q1-2003q2	Current transfers (bal. of payment)	80.27 [3.05]	46.53 [4.85]	log(t)	0 *	0 *	0 *	0.424
FDI ⁺ 1995q1-2003q2	Foreign direct investments	0 *	24.66 [11.49]	t	0 *	0 *	0 *	0.740
INBAL 1995q1-2003q2	Income (bal. of payment)	0 *	-89.05 [-11.45]	log(t)	0 *	85.63 [2.22]	96.172 [2.47]	0.487

t-values in []; * restricted parameter; ⁻ D9798 – .198699 [5.97599];

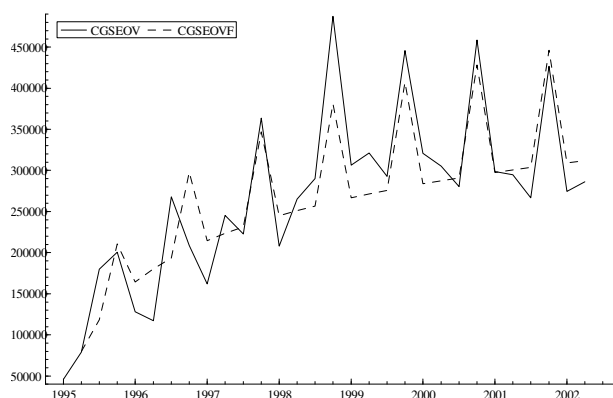
⁺ Dtel (1 in 1998q3; else – 0) – 1553.51 [6.4]; Dmaz (1 in 2002q2; else – 0) – 523.597 [2.102].

Figure 39 Exogenous Variables, Fits and Real Values (simple forecasts)

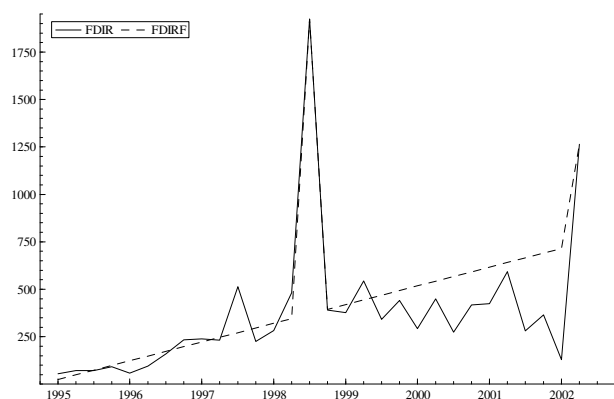
Governmental Expenditure



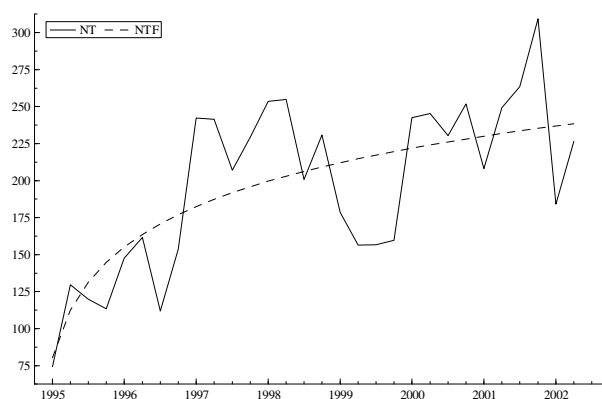
SSSF Expenditure ex. Pensions



Foreign Direct Investments



Net Transfers



A quick analysis of Figure 39 reveals that, in most cases simple extrapolation catches the macroscopic component and seasonal changes reasonably well. However, in some cases (foreign direct investments (*FDI*), net transfers (*NT*)), ‘official’ forecasts would be preferable. We should notice, for instance, that changes in the stock of foreign direct investments are very sensitive to privatisation of huge publically owned companies such as “Lietuvos telekomas”, “Mazeikiu nafta”. But we assume that fluctuations in these time series would stabilise after the Government completes the privatisation process of publically owned enterprises.

Concerning the governmental consumption, (*CGRN*) and SSSF’s expenditure (*CGSEOV*), we use the seasonal components from the estimations in Table 24 and assume approximately the same growth rate as GDP within the baseline scenario (approximately 3% per year).

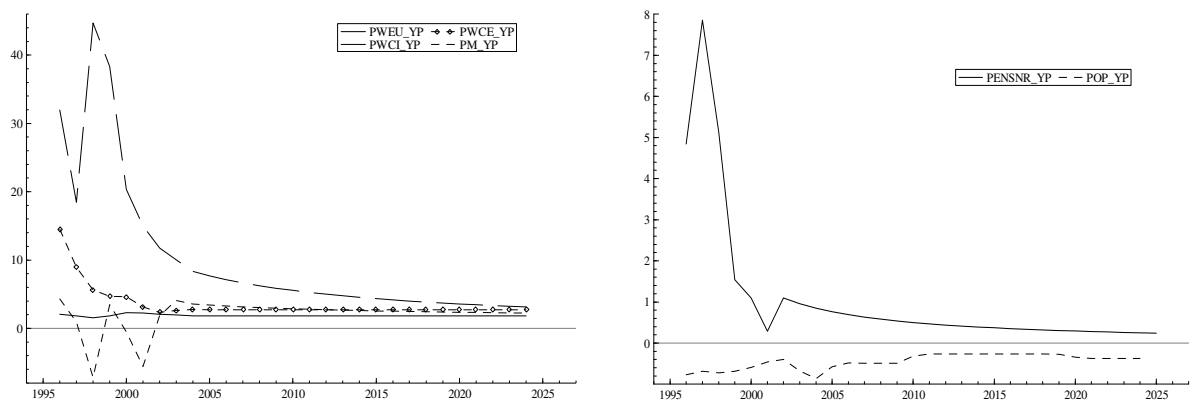
For the population (*POP*), we use the official forecast from Statistics Lithuania presented in Table 25. We use a linear interpolation between the forecasted values.

With regard to the number of pensioners (*PENSNR*), the forecast in Table 25 of people over the age of 60 has almost the same growth rate as the simple forecast in Table 24. However, the number is not identical in the historical period, so we use the simple forecast in Table 24.

Table 25 Forecasts of Population Number in 2005-2030

Year	Population Number, thous.				Percentage of Total			
	Total	0-14	15-59	60+	Total	0-14	15-59	60+
2005	3406.3	585.9	2127.6	692.8	100.0	17.2	62.5	20.3
2010	3323.9	503.0	2119.8	701.1	100.0	15.1	63.8	21.1
2020	3236.7	545.5	1932.6	758.6	100.0	16.9	59.7	23.4
2030	3117.2	510.9	1755.2	851.1	100.0	16.4	56.3	27.3

Changes in population (*POP*) and the number of pensioners (*PENSNR*) are illustrated in Figure 40 (right).

Figure 40 Yearly Growth Rates of Foreign CPI's, and P_M (left) and the Number of Population and Pensioners (right)

The data on foreign consumer price indices for the three groups of countries (EU, CIS, CE) and the aggregated GDP growth rate for Lithuania's export market is built on annual data. For long-term forecast, we assume that the series continue to grow at the same rate as they do in 2004 (the last year officially forecasted by IMF). However, in the case of consumer price index for CIS countries, we use a constant absolute growth rate rather than a yearly growth rate. It gives the convenient status that the annual growth rate of CPI in CIS countries decreases rather quickly from 8% annual growth to a reasonable value of 3% (see Figure 40, left). In the long-run, this ensures a moderate rate of inflation in CIS. The corresponding annual growth rates for Central Europe and EU countries are fixed at 2.7% and 1.8%, respectively.

The import price index (*PM*) is a very important determinant for most of the price indices in the model (see Section 10). It is assumed to be a weighted average of foreign CPI with the weights equal to the import shares relating to these groups in 2001.

$$P_M = (P_M)_{-1} \cdot \left[0.64 \frac{PR_{EU}}{(PR_{EU})_{-1}} + 0.26 \frac{PR_{CIS}}{(PR_{CIS})_{-1}} + 0.10 \frac{PR_{CE}}{(PR_{CE})_{-1}} \right] \quad (96)$$

Where

P_M Import price

PR_j Real consumer price index in corresponding groups of countries (EU, CIS, CE)

The remaining exogenous variables are assumed to follow naive no-change forecasts. The variables are: average working hours per week (*workhour*, equal to the mean over the estimated period 1995q1-2002q2), average annual interest rate on loans (*RA*, the historical rapidly moving towards the zero level seemed to be unreasonable), real effective exchange rates (*REEREU*, *REERCE*, *REERCI* - following the EU entrance, we assume fixed exchange rates of the CIS and Central European currencies to the Euro), depreciation rate (*delta*, 2.5%). In addition, a number of policy variables were fixed during the simulation of the baseline scenario: Different tax rates (on personal (*TL*) and corporate (*TC*) income, VAT, social security contribution rate (*ssc*), other government receipts (*TP*)), and the non-taxable minimum wage (*ntmin*).

We included in the estimations a time trend in several equations. In the forecasting period we maintain the estimated trend in the labour demand equations only.

In conclusion, we would like to stress that a simple extrapolation may give unreasonable forecasts. Future structural changes need to be taken into account and somehow included into the model in the form of rational expectations or other alternative estimations described earlier in this section. In the case of Lithuania, a very illustrative example could be the effect of the EU entrance on Lithuanian economy in 2004, an analysis of which could be found in [EU, Vilnius 2003]. In the long-run rational expectations give crucial information about the performance of Lithuanian economy, and could considerably improve forecasting with the existing LITMOD. For instance, the effect of the EU entrance could be included through exogenous factors, e.g., influencing the balance of payment. But the analysis of this is beyond the scope of the present paper.

11.3.2. Baseline Scenario

This section shows a baseline scenario using the forecast of exogenous variables described in the last section. Alternative simulations used for sensitivity analysis are examined in the next section.

Three main periods of time are chosen for the examination of growth rates: The historical period (1996-2002), the short-term forecast period (2003-2005), and the long-term forecast period (2006-2020). We examine the following main LITMOD variables:

- Components of GDP calculated by expenditure approach (real private consumption (*CRN*), total capital investments (*IRT*), real export (*XRN*), and import (*MRN*)) and total gross value added (*GDPT*);
- Price indices (consumer price (*PC*), aggregated producer price (*PQ*), price on investments (*PI*), and export price (*PX*));
- Labour market's components (total labour demand (*LNT*) and labour supply (*LS*)).

In some cases, it is informative to compare the simulated growth rates with appropriate exogenous variables, e.g., GDP for the Lithuanian foreign trade market (*GDP_{WR}*), import price index (*PM*), and the population (*POP*).

The model produces quarterly forecast. However, in this section, we focus on annual growth rates in percentage. However, in Figure 43 (right) we show the simulated quarterly forecasts

for the different price indices and we see that there is a clear seasonal pattern in the forecast as well as in the historical period. Although we find such pictures interesting, they are less informative than plots drawing the annual growth rates of the variables.

Figure 41 Annual Growth Rates of GDP Components (Expenditure Approach)

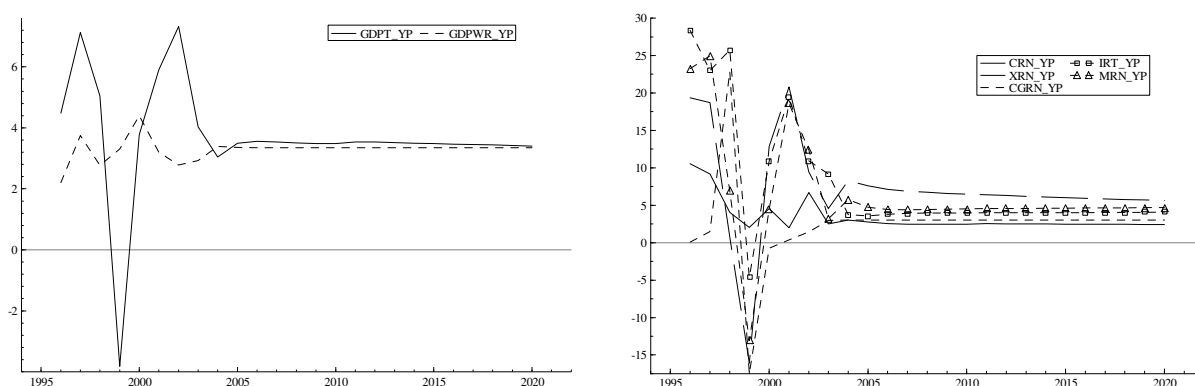


Figure 41 (left) illustrates that the GDP growth in most of the European countries (*GDPWR*) was not so greatly affected by the Russian crisis, as the GDP in Lithuania (*GDPT*) was. The right-hand side of the figure reveals that the Russian crisis had a significant lagged effect on almost all GDP components except private consumption (*CRN*, solid line).

In the historical period, there were large and fluctuating growth rates in GDP and components of GDP, e.g., 28.4% in capital investments (*IRT*) and 20.8% in export (*XRN*). The baseline scenario shows a much more stable economy with lower growth rates. The main reason for the stability is that we cannot predict if and when there will be major outside shocks to the economy such as the Russian crisis.

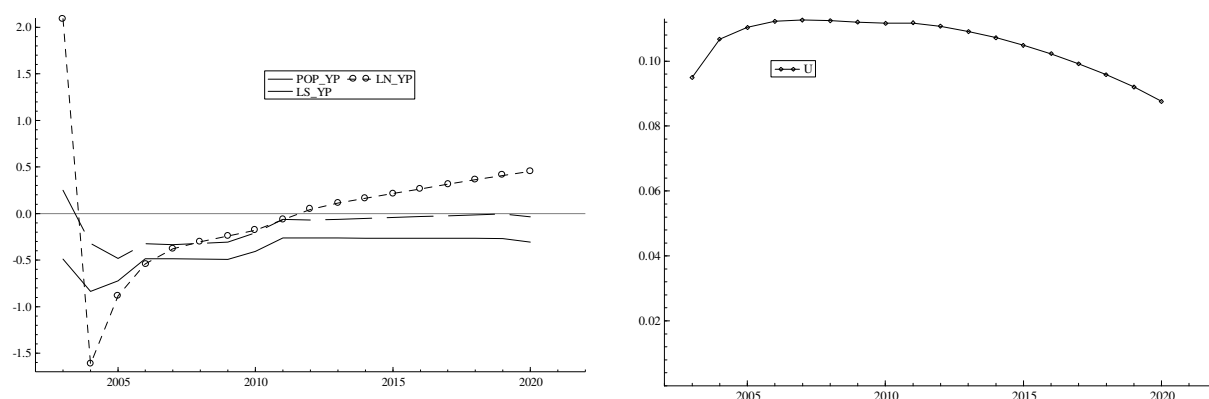
The forecasted annual GDP growth rate in Lithuania is a bit above the GDP growth rates in the Lithuanian foreign trade market (in average 3.49% and 3.35%, respectively). In the long-term forecast, private consumption (*CRN*) has the lowest annual growth rate of 2.48% of the GDP components, and export (*XRN*) has the largest annual growth rate of 6.25%.

Table 26 Annual Growth Rates of GDP Components (by Expenditure Approach) in Three Periods (all in %)

		CRN	GDPT	IRT	XRN	MRN	CGRN	GDPWR
		Private consump.	GVA	Invest- ments	Export	Import	Public consump.	Foreign GDP
1996- 2002	mean	5.58	4.26	16.25	9.39	11.07	1.14	3.20
	st. dev.	3.35	3.80	11.44	13.25	13.19	11.72	0.72
	min	1.20	-3.82	-4.63	-16.11	-13.08	-17.48	2.20
	max	10.55	7.33	28.37	20.81	24.96	22.86	4.40
2002- 2005	mean	2.77	3.52	5.50	6.83	4.57	2.99	3.22
	st. dev.	0.26	0.49	3.19	1.98	1.30	0.01	0.26
	min	2.50	3.05	3.58	4.57	3.19	2.98	2.93
	max	3.02	4.03	9.19	8.30	5.78	3.00	3.39
2006- 2020	mean	2.48	3.49	3.99	6.25	4.57	3.00	3.35
	st. dev.	0.04	0.04	0.07	0.45	0.10	0.00	0.00
	min	2.40	3.41	3.81	5.64	4.39	3.00	3.35
	max	2.55	3.56	4.09	7.14	4.68	3.00	3.35

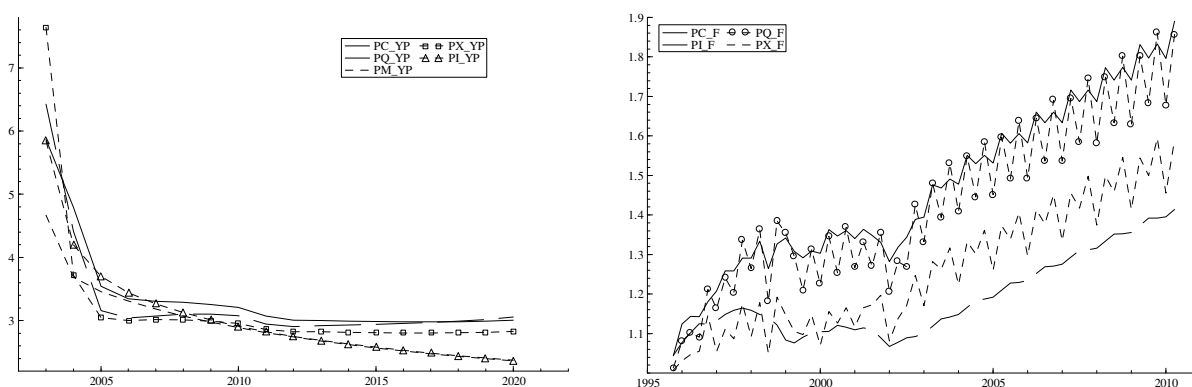
As seen in the model section, simulated labour supply (*LS*) fluctuates like the population (the same form of path). In the forecast, the population (*POP*) is decreased by approximately 0.5% each year. However, the labour supply is only decreased by approximately 0.2% each year (see Figure 42, left) due to an increase in the real wage in the forecast. Total labour demand (*LN*) (the main production factor) decreases in the short to medium-term and increases in the long-term up to 0.5% each year (but is only 0.04% per year in average). These forecasts of the labour supply and demand cause the unemployment rate to go below 9% in the long-term forecast.³⁴

Figure 42 Annual Growth Rates of Labour Market Components (left); Unemployment Rate (right)



Being tightly related, all prices have the same long-term dynamics. Annual growth rates decline rather quickly and stabilise at around 3% growth per year, except the price index on investment (*PI*), which declines beyond this level, closely following the growth rate of the import price (*PM*). Figure 43 (right) illustrates the quarterly development of the price indices, and Figure 43 (left) shows the more illustrative annual growth rates.

Figure 43 Annual Growth Rates of Price Indices (left); and their Quarterly Forecasts (right)



³⁴ However, it is still above the 6% of natural unemployment rate assumed in most of the developed countries.

Table 27 Annual Growth Rates, Labour Market Components and Price Indices in Three Periods (all in %)

		POP	LN	LS	PC	PX	PQ	PI	PM
		Popula- tion	Labour demand	Labour supply	Price on consum.	Price on export	Producer price	Price on investm.	Price on import
1996- 2002	mean	-0.64	-1.91	-1.14	4.89	2.38	4.65	1.09	-0.82
	st. dev.	0.14	2.62	3.20	6.24	5.05	6.81	6.14	3.69
	min	-0.78	-5.86	-7.64	-0.53	-3.75	-1.77	-7.36	-4.69
	max	-0.37	0.94	1.76	17.03	10.68	19.34	11.40	4.72
2002- 2005	mean	-0.68	-0.14	-0.19	4.73	4.80	4.66	4.58	3.94
	st. dev.	0.18	1.96	0.39	1.17	2.48	1.65	1.12	0.64
	min	-0.84	-1.62	-0.48	3.54	3.05	3.16	3.70	3.46
	max	-0.49	2.09	0.25	5.87	7.64	6.43	5.85	4.67
2006- 2020	mean	-0.34	0.04	-0.13	3.09	2.88	3.00	2.76	2.74
	st. dev.	0.10	0.31	0.13	0.14	0.09	0.07	0.33	0.20
	min	-0.49	-0.54	-0.34	2.98	2.81	2.90	2.37	2.36
	max	-0.26	0.45	-0.01	3.35	3.02	3.10	3.44	3.31

This baseline scenario depicts a rather agreeable long-term performance of LITMOD assuming the most probable development of exogenous factors. In the long run, it shows an almost 3.5% growth of the total gross value added (*GDPT*) and a higher rate of annual growth for export (*XRN*, 6.2%) than import (*MRN*, 4.6%). Price growth is approximately at half the rate of average wage in the private sector (*WPRI*, 6.6% per year). The labour market is closely related to the dynamics of the population (*POP*) and the gross domestic production (*QRT*).

11.4. Simulations

In this section, we change some of the exogenous variables – one at the time – simulate the model, and look at the percentage change in the endogenous variables. The simulations are based on the presented baseline scenario and are carried out in 2002q3-2008q4. In general, the model reached a new equilibrium rather quickly. We mainly focus in this section on the long-term effects.

These simulations will provide a better understanding on how the model is working and the important linkages between the variables in the model.

11.4.1. Price on Import Increased by 1%

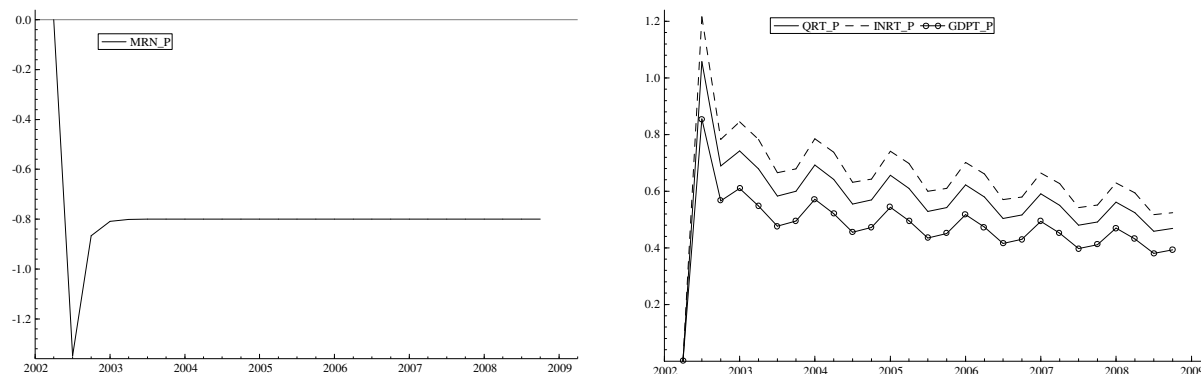
In the first simulation, we increase the price on import (P_M) permanently by 1%. Firstly, we look at the percentage change in the quantities and then at the prices. At the end, we simulate the whole model and discuss the overall effects of the increased price on import.

The direct effect on import is -0.80% in the long-run and -1.35 in the first quarter (i.e., the estimated import price elasticities). Due to the large estimated error correction parameter in the import relation, the long-term adjustment is done in three quarters. This is illustrated in Figure 44 (left) showing the percentage change in import (*MRN*).

With unchanged demand (keeping private consumption, public consumption, investments, and export fixed at the baseline level), the domestic production (*QRT*) is increased to fulfil the lack of decreased import as illustrated in Figure 44 (right). Intermediate (*INRT*) is increased slightly more than the increase in production, and hence the value added (*GDPT*) is increased

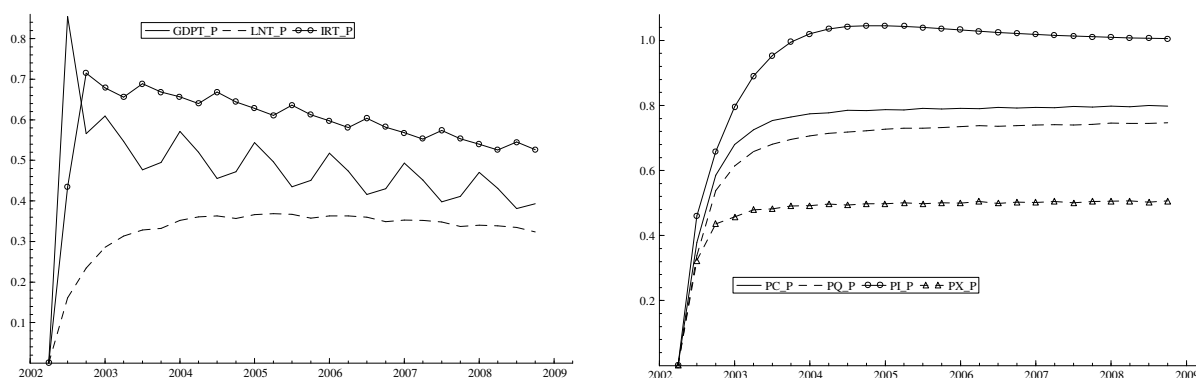
less than domestic production.³⁵ However, looking at the unexpected quarterly pattern of the changes in production, etc., in Figure 44 (right), there seems to be a minor problem with the seasonal adjustment in the simulations.

Figure 44 Direct Effect on Import (left) and Domestic Production (right)



Increasing GVA increases the demand of labour and investments in sectors as illustrated in Figure 45 (left). The short-term effect is greater on investments than on labour demand due to the estimated short-term parameters. In the long-run, equilibrium labour and investments increase with approximately the same percentage as GDP (due to constant return to scale in the production). Again, the increased investments increase domestic production and investments within sectors. However, this simultaneous relationship between investments and domestic production has a limited effect.

Figure 45 Demand for Labour and Investments (left). Prices (right)



We have looked at changes in the real value variables (the quantities). We now turn to the domestic price determination due to the increased import price.

Domestic prices depend heavily on the import price as seen in Figure 45 (right). After a few quarters, when the import price has increased by 1%, the price on domestic production (PQ) is increased with 0.75%. The average estimated weight to the import price is 0.3, so the rest of the increase in the domestic producer price is due to increased price on investments. In the long-run, the price on investments (PI) depends only on the import price and is hence increased by 1%, and the price on investments is, in the medium-term, increased even more

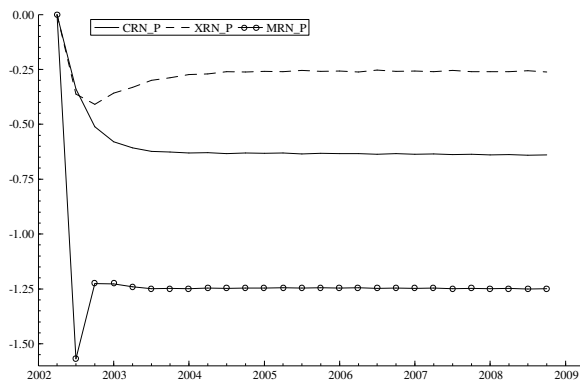
³⁵ Aggregated intermediate is not increased with exactly the same rate as aggregated production due to structural changes between the sectors and different shares of import in the intermediate in sectors.

than 1%.³⁶ Increasing price on import and on domestic production increases the price on private consumption (PC) by 0.8%. Finally, due to the increase in the domestic producer price, the price on export (PX) is increased by 0.5%.

The increased price on private consumption (PC) decreases the real disposable income and hence private consumption (CRN) is decreased as seen in Figure 46. Due to the estimated long-run export price elasticity of -0.5 and -1.1 in the short-run, the increase in the export price of 0.5% decreases the export (XRN) by 0.25% in the long-run and more in the short-run.

In the model, import (MRN) depends on the private consumption and the relative import price (PM/PC), and since private consumption is decreased by 0.6% and the relative import price is increased by 0.2% (PM increased by 1% and PC increased by 0.8%), the import (MRN) is in the long-run decreased by 1.2% as seen in Figure 46. This could be compared with the direct decrease of import by 0.8% in Figure 44 (left).

Figure 46 Consumption, Export and Import

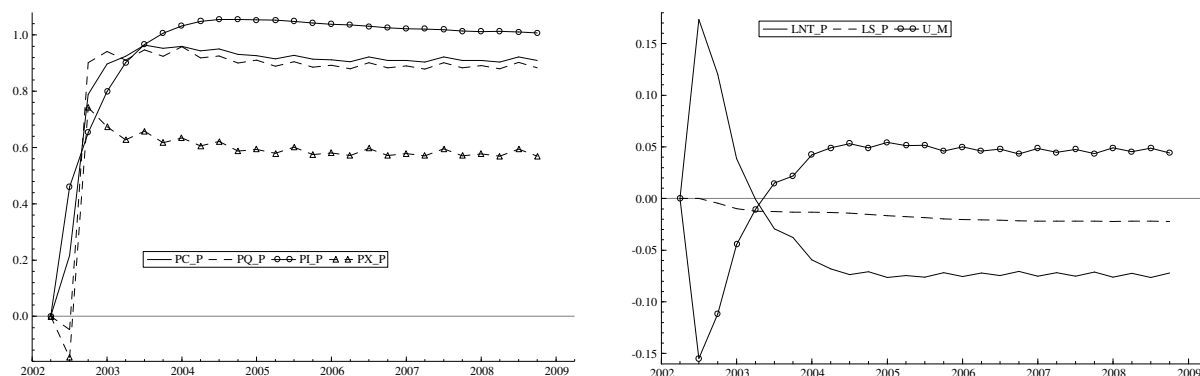


Finally, we simulate the whole model and hence look at the model interactions in terms of quantities and prices. It is not easy to explain all the effects in details, but the above comments to simulations of smaller parts of the model should give some insight on how the model works.

First of all, the domestic producer price (PQ) is further increased in the simulation with the whole model since the nominal wage is in the long-run increased by 0.6%, and hence the price on consumption (PC) and on export (PX) is increased more. The nominal wage is increased because the price on consumption is increased, but the increase in the wage is less than the increase in the consumer price due to a minor increase in the unemployment rate (U) of 0.05 %-point – see Figure 47 (right).

³⁶ The effect on investment price (PI) of a change in the import price (PM) gives an unintended additional increase in the producer prices (PQ). It should be considered either to let the price on investments be exogenous in the model or to fix the parameters in an estimation of the equation so the price on investments mainly depends on domestic producer prices.

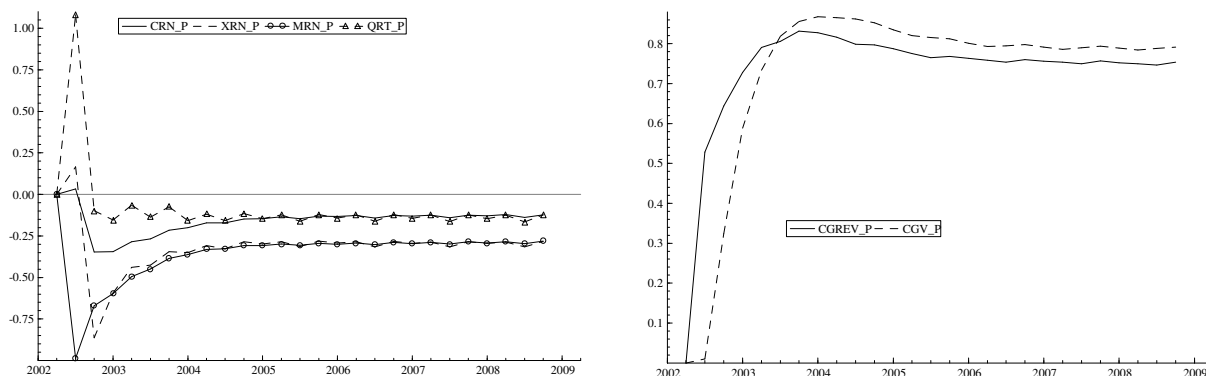
Figure 47 Whole Model Simulated, Prices (left) and Labour Market (right)



Looking at the percentage change in the quantities in Figure 48 (left), we see that the domestic production (QRT) is only increased in the first quarter due to the decrease in import. As explained above, private consumption (CRN) and export (XRN) is decreased due to increased prices, so total demand is decreased and hence domestic production is also decreased. In the long run, both import and export is decreased by -0.3% , and both domestic production and private consumption is decreased by -0.1% .

In Figure 47 (right), we see that the demand for labour in sectors (LNT) is increased in the first quarter and since decreased as the domestic production. There is a minor decrease in the labour supply (LS) due to a decrease in the real wage ($WPRI/PC$).

Figure 48 Whole Model: Quantities (left) and Governmental Balance (right)



As seen in Figure 48 (right), the governmental balance has worsened (not much) since the expenditure to the public consumption (CGV)³⁷ has increased more than the governmental revenue ($CGREV$).

11.4.2. Public Consumption Increased by 1%

We saw in the above experiment the effects of changing one of the exogenous prices. In this experiment, we change one exogenous demand component and explain the changes in the simulated endogenous variables.

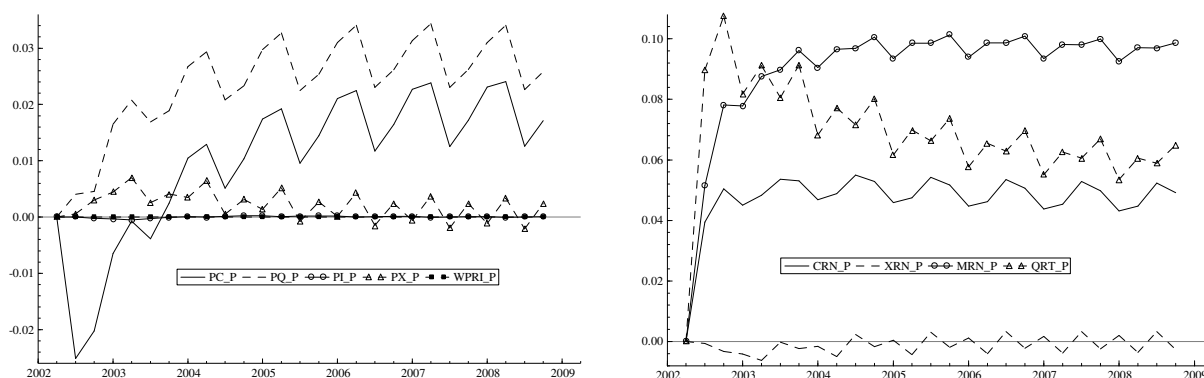
³⁷ The price on public consumption (PCG) is increased due to the increase in the producer prices, and the quantity of public consumption ($CGRN$) is exogenous.

Public consumption in constant prices (*CGRN*) is permanently increased by 1%.

The direct effect is that production in the public sector (*S4*) is increased by 1%, and the total production (*QRT*) is increased by 0.14%. This increases the demand for labour and investments in sectors.

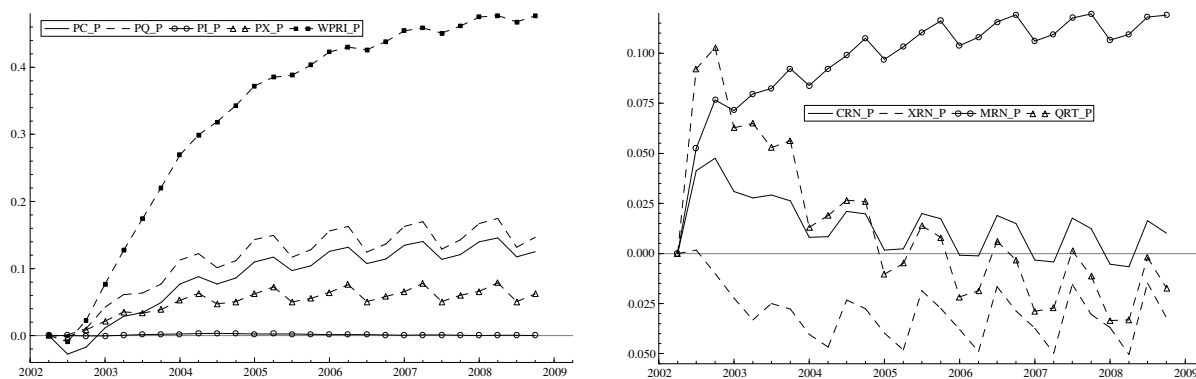
Keeping wages fixed at the baseline level, there are minor price changes as seen in Figure 49 (left). Therefore, the percentage change in the quantities presented in Figure 49 (right) is almost the same as with exogenous prices (except import which is very sensitive to an increase in the price on private consumption). As explained above, production and hence labour demand is increased. A higher rate of employment increases the disposable income, so private consumption is increased and thereby also import.

Figure 49 Simulation with Wage Fixed, Prices (left) and Quantities (right)



By simulating the model with wage rate endogenously, the percentage changes in prices and quantities are shown in Figure 50. Because of the decreasing unemployment rate, the nominal wage (*WPRI*) is increased, and the wage is very sensitive to changes in the unemployment rate. An increased wage increases production costs and hence the domestic producer price (*PQ*) and other domestic prices (*PC* and *PX*). In the long-run, this results in an (almost) unchanged private consumption (*CRN*), so an increase in the public consumption has a positive short-term effect only.

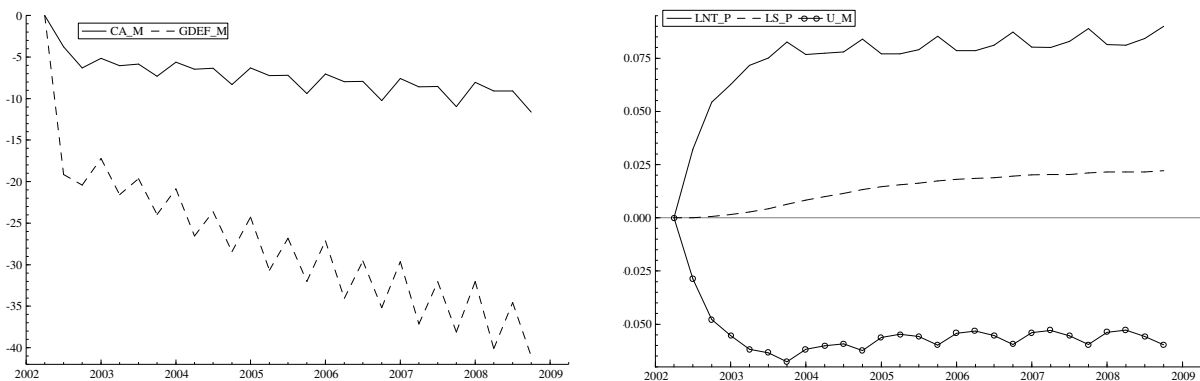
Figure 50 Percentage Change in Prices (left) and Quantities (right)



Since import increases and export decreases, the balance of the current account (*CA*) is worsened by more than 5 mill. Litas each quarter as seen in Figure 51 (left). The

governmental balance ($GDEF$) is also worsened because the public consumption is increased without a similar increase in the governmental revenue.

Figure 51 Balances (left) and Labour Market (right)



There is a minor long-term increase in the labour demand (LNT) of 0.075% as seen in Figure 51 (right). The labour supply (LS) is increased due to an increase in the real wage ($WPRI/PC$).

11.4.3. Export Market Increased by 1%

In this experiment, we examine the influence of a 1% increase in the export market, i.e. a 1% permanent increase in the GDP in the Lithuanian foreign trade market (GDP_{WR}).

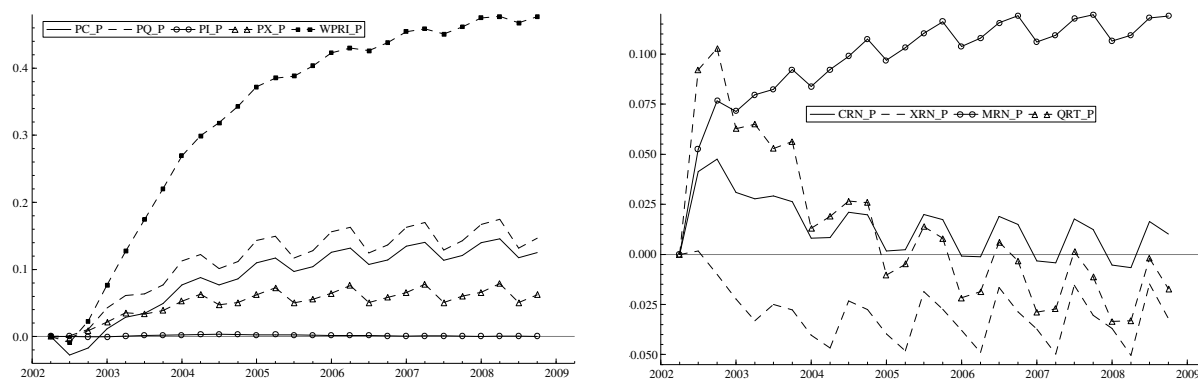
The foreign GDP growth (GDP_{WR}) has a direct influence on the amount of export from Lithuania to the foreign countries. The direct effect is that real export (XRN) is in the long-run increased by 1.6% (the estimated long-term parameter). In order to export more goods and services, the Lithuanian economy requires an increased domestic production (QRT). Consequently, this leads to increases in the demand of labour (LNT), and investments in sectors (IRT).

Larger labour demand decreases the unemployment rate (U), and hence increases wage ($WPRI$). By increasing household disposable income, and hence private consumption, (CRN) is increased.

Increased wage increases production costs and, therefore, the producer price (PQ) and hence the consumer price (PC) and export price (PX) increases. This gives a reverse effect on private consumption and export, so that the increases are lowered.

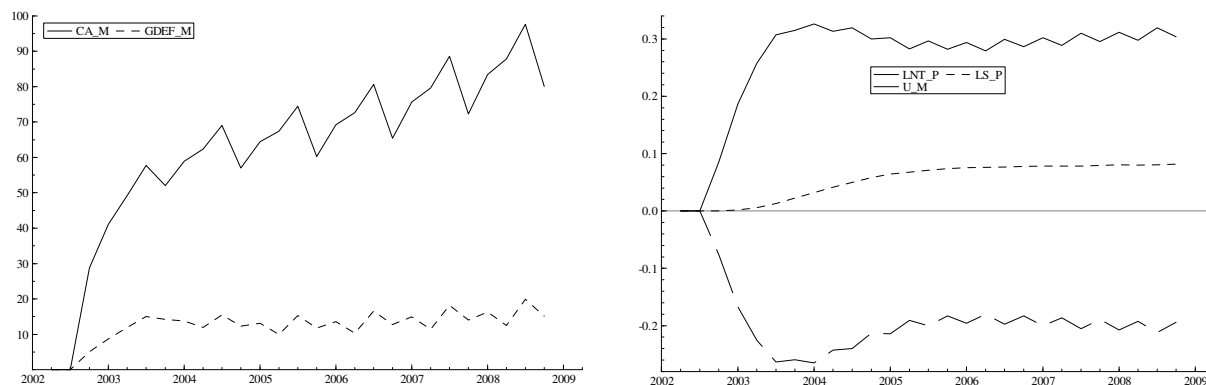
As seen in Figure 52 (right), import (MRN) is increased in the long-run by approximately 1% due to the increase in private consumption and a decrease in the relative import price (PM/PC).

Figure 52 Percentage Change in Prices (left) and Quantities (right)



Since the increase in export is greater than the increase in import, the current account (CA) is improved in average as seen in Figure 53 (left) by 72 mill. Litas each quarter. Increased government revenue results in a 14 mill. Litas decrease in budgetary deficit each quarter.

Figure 53 Balances (left) and Labour Market (right)



Finally, Figure 53 (right) shows the total effect on the labour market of an increase in the foreign GDP growth. Increased production requires more labour, and there is a 0.3% increase in the labour demand (LNT). There is a slight increased labour supply (LS) due to the increased real wage. This leads to a relatively small 0.2%-point decrease in the unemployment rate (U).

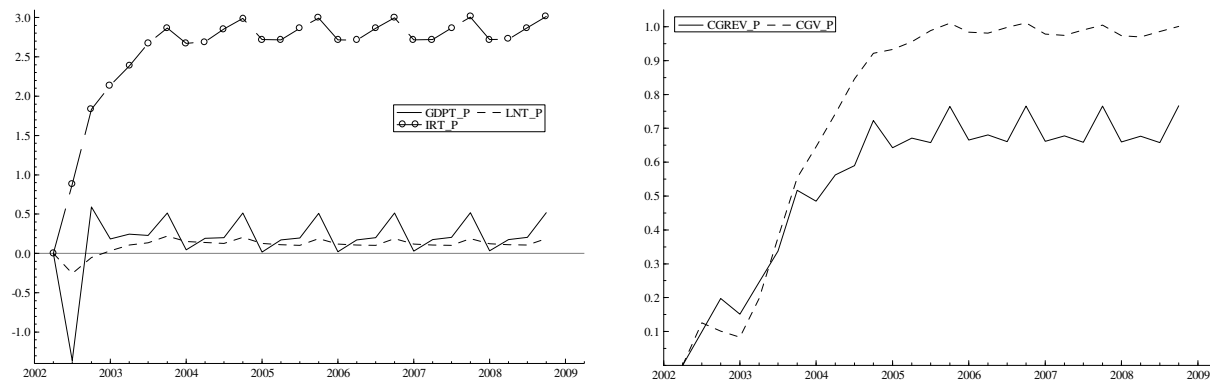
11.4.4. Interest Rate Decreased by 1%-point

One of the most important exogenous variables in simulation experiments regarding monetary policy is the annual interest rate (RA). In this experiment, we permanently decrease the interest rate by 1 percentage point.

The interest rate directly influences the price on investments (PI) and the demand for investments (IRT).³⁸ The increase in the domestic investments increases the domestic production (QRT) and hence GDP and the labour demand (LNT) as shown in Figure 54 (left).

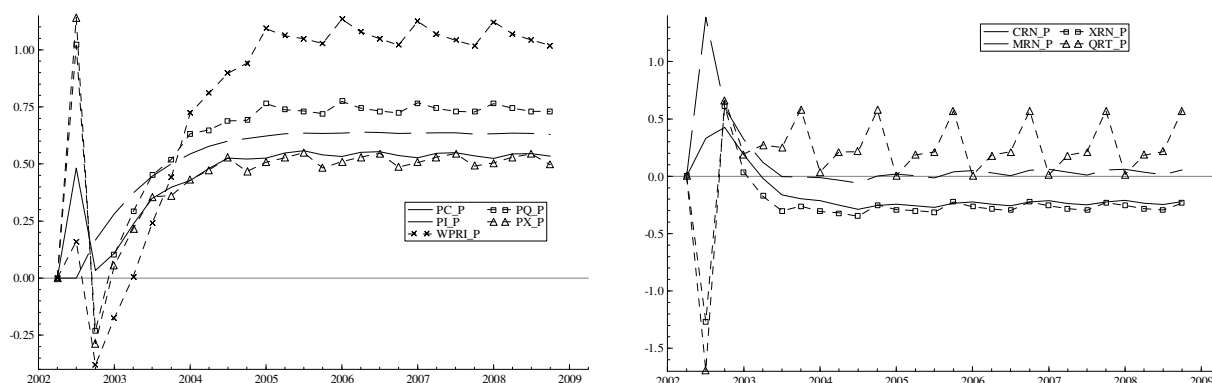
³⁸ A decrease in the interest rate increases the demand for investments, but on the other hand, a lower interest rate increases the price on investments (see Section 10.6), and hence the demand for investments is decreased. The overall effect is an increase in the investments as expected. Once again, we should mention that the current equation for the price on investments should be reconsidered.

Figure 54 Percentage Change in Quantities (left) and Government Finance (right)



The production costs are increased due to a higher price on investments and primarily due to a higher wage (the wage is increased because of increased labour demand). So, the producer price (PQ), and hence the consumer price (PC) and export price (PX) are increased in the long-run as seen in Figure 55 (left). Therefore, in Figure 55 (right), we see a long-run decrease in private consumption (CRN) and export (XRN). In the long-run, the import (MRN) is almost unchanged (decreased due to the decrease in private consumption and increased due to a decrease in the relative import price, PM/PC).

Figure 55 Percentage Change in Prices (left) and Quantities (right)

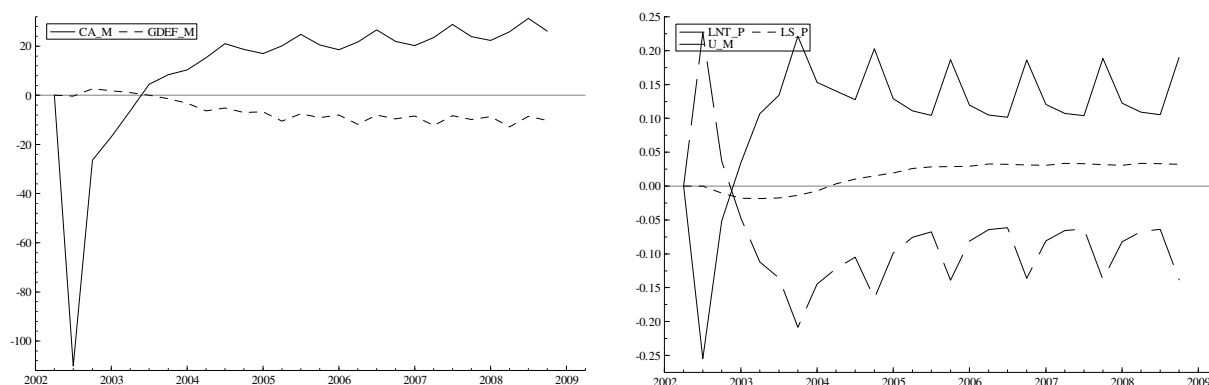


The overall long-term effect is an increase in total capital investments (IRT) by 2.82%, and the price on investment (PI) is increased by 0.5%. There is a 0.24% decrease in private consumption (CRN) and a 0.28% decrease in export (XRN).

Governmental expenditure (CGV) will in the long-run increase up to 1% (due to a 1% increase in the price on public consumption, PCG), which exceeds the corresponding growth of governmental revenue ($CGREV$) as seen in Figure 54 (right). It follows that there will be an increase of 8.3 mill. Lit. in the budgetary deficit ($GDEF$) as shown in Figure 56 (left).

There is after one year a positive change each quarter in the current account balance (CA) of 21 mill. Lit. Import is almost unchanged, and the value of export is increased because the price on export is increased more than the export is decreased.

Figure 56 Balances (left) and Labour Market (right)



Increased average wage in the private sector ($WPRI$) increases labour supply. Moreover, significant capital investments lead to the creation of new working places and hence an increase in the labour demand. Since labour demand increases more than the labour supply, the unemployment rate is decreased by 0.1%-point as seen in Figure 56 (right).

11.4.5. VAT Rate Decreased by 1%-point

There are a number of policy variables in the model that could be used for different simulation exercises concerning fiscal policy modelling, e.g., different tax rates. In this experiment, we examine the effect of the VAT rate being permanently decreased by 1%-point.³⁹

The VAT decrease has two direct effects in the model. The governmental VAT revenue ($CGREV$) is decreased by 1%, and there is a decrease in the consumer price (PC) of 1%.

When the consumer price is decreased by 1%, the private consumption (CRN) is in the long-run increased by 0.8% and by 0.9% in the first quarter meaning that the consumption expenditure ($PC \cdot C$) is almost unchanged. Increasing private consumption increases import (MRN). The direct effect from the private consumption is that import is increased by a factor 1.7, but since the relative import price (PM/PC) is increased, the import is increased less than the private consumption.⁴⁰

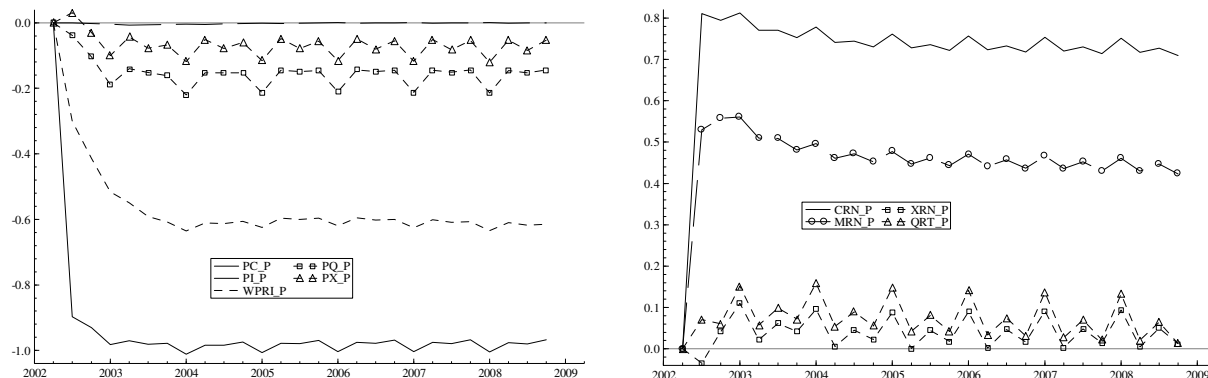
There is full compensation in the wage equation for price changes, so the wage ($WPRI$) is decreased as much as the consumer price (PC). However, due to a minor decrease in the unemployment rate (U), the wage is not decreased as much as the consumer price (see Figure 57 (left)), so the real wage ($WPRI/PC$) is increased in the simulation. Lower wage decreases the production costs and the labour demand is increased.

Figure 57 (right) shows that domestic production (QRT) is only increased by 0.1% since the increased private consumption is mainly covered by an increasing import.

³⁹ We should notice that the VAT rate in the model is only paid of private consumption, whereas there is a 'net tax rate on products' (tp). Therefore, this experiment does not thoroughly cover a VAT rate decrease.

⁴⁰ Looking at a VAT rate decrease in the model, we should maybe additionally decrease the import price.

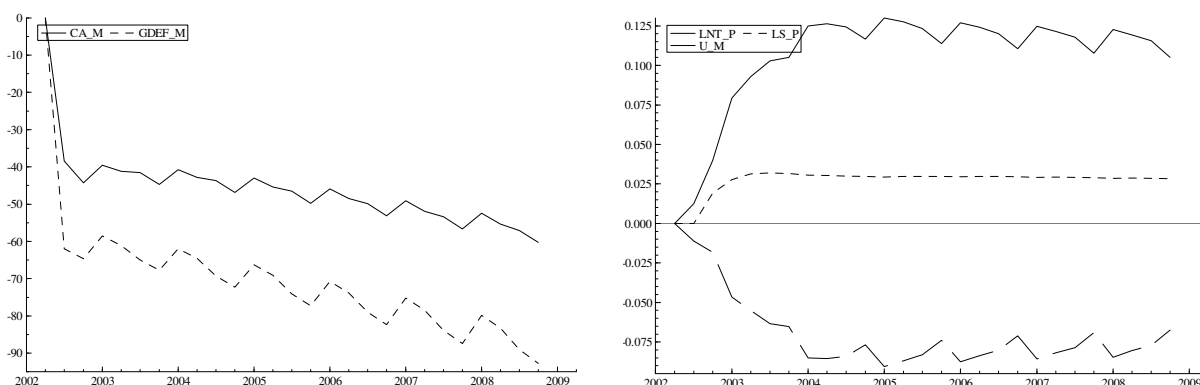
Figure 57 Percentage Change in Prices (left) and Quantities (right)



Export (XRN) is almost unchanged, and import (MRN) is largely increased by 0.45%. Therefore, each quarter, we see in Figure 58 (left) a 49 mill. Litas decrease in the current account (CA). Due to the lower VAT revenue, there is a 79 mill. Litas increase in the governmental deficit ($-GDEF$).

There are only minor changes in the labour market as seen in Figure 58 (right). The labour supply is increased by 0.025% due to an increase in real wage ($WPRI/PC$), and labour demand is increased by 0.12%, resulting in the unemployment rate being decreased by 0.08%-point. This is a small effect of a 1% decrease in the VAT rate.

Figure 58 Balances (left) and Labour Market (right)



However, we should notice that the present model has only a simple block of equations representing governmental finance and hence is, in some cases able to provide approximate answers to questions of fiscal policy only.

11.4.6. Population is Increased by 1%

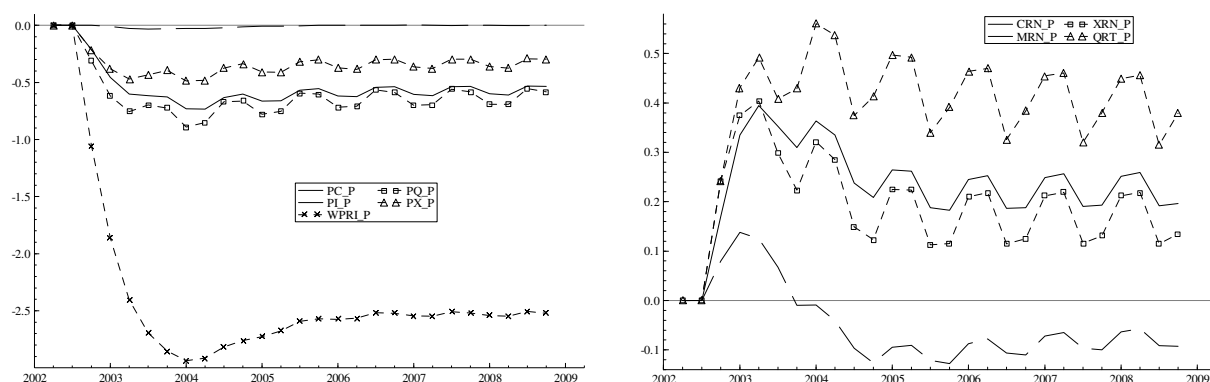
We analyse in this last experiment the influence of a more optimistic point prediction of the number of population in Lithuania. This variable is crucial for the labour supply. The population (POP) is permanently increased by 1%.

The direct effect is that labour supply (LS) is increased by 1% both in the short and long-run. By keeping wages fixed at the baseline level, the 1% increase in labour supply is the only effect, and the unemployment rate (U) is proportionally increased.

With a fixed level of labour demand, the unemployment rate (U) is proportionally increased. In the model, the wage is very sensitive to changes in the unemployment rate and the wage (WPR) is, therefore, decreased by 2.6% as seen in Figure 59 (left). A decreasing real wage means less labour supply, and the overall effect on the labour supply is an increase by almost 1% in the short-run and by 0.87% in the long-run.

The decrease in the wage reduces production costs and there is hence a decrease in the producer price (PQ). This decreases the consumer price (PC) and export price (PX), which leads to an increase in private consumption (CRN) and export (XRN). The import (MRN) is decreased by 0.1% composed of an increase due to the increase in the private consumption and a decrease due to the increase in the relative import price (PM/PC). This is shown in Figure 59.

Figure 59 Percentage Change in Prices (left) and Quantities (right)



The increased demand increases the domestic production (QRT) and hence the demand for labour (LNT) as well as investments. The labour demand is somewhat increased more than the domestic production due to the decreased wage. Figure 60 (right) shows that, a 1% increase in the population will, in the long-run, increase the unemployment rate (U) by 0.3%-point, so the main part of the additional population is transferred to employment.

Figure 60 Balances (left) and Labour Market (right)

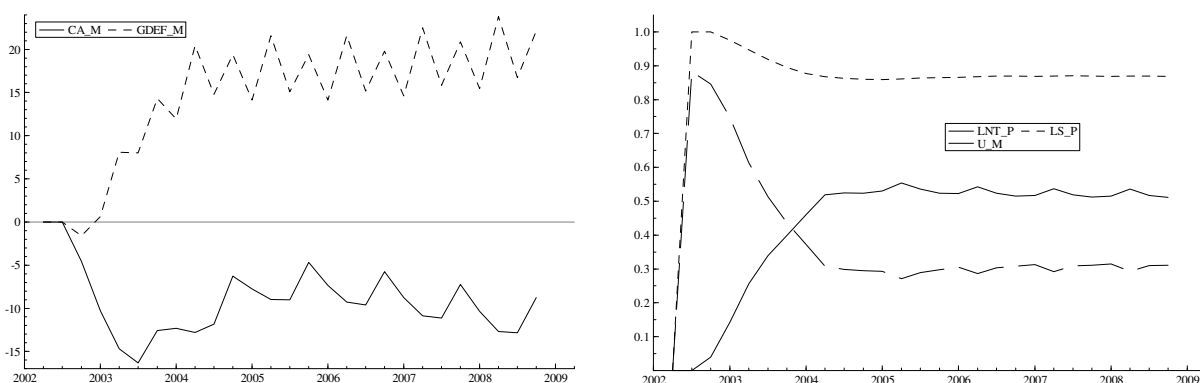


Figure 60 (left) shows that the current account (CA) is worsened by approximately 10 mill. Litas each quarter because the value of the export ($PX \cdot X$) is decreased more than the decrease in the value of the import ($PM \cdot M$), (PX is decreased by 0.3%, X is increased by 0.2%, M is decreased by 0.1%, and PM is unchanged).

An increase in the population improves the governmental balance as seen in Figure 60 (left). This covers a decrease in the public expenditure (*CGV*) of 1.3%,⁴¹ and a decrease in the governmental revenue (*CGREV*) of 0.8%. The wage is decreased so much that the increased employment does not give the households a larger wage income, and hence the tax bases are decreased.

This experiment shows that the effect on the wage (*WPRI*) from a change in the unemployment rate (*U*) is too great (if the unemployment rate is increased by 1%-point, the private wage is in the long-run decreased by 5%, (see Section 10.9). It would have been expected that the governmental revenue be increased in this experiment, since the employment is increased.

11.5. Concluding Remarks

In general, the simulations show that the model work appropriately for medium-term forecasts and structural analyses of the Lithuanian economy. However, if the model is to be used for more detailed policy analyses, the equations describing the Governmental finance should be further developed. The simulations and sensitivity analyses also point out equations where further developments may improve the model properties, e.g.:

- Wage determination: In the equation for the wage rate in the private sector, the effect of the unemployment rate is very large. In simulations, this implies that changes in, for example, the supply of labour and employment have a very small effect on disposable income and thereby private consumption and production.
- Price determination: The prices on final consumption (*PC*, *PI*, *PX*) should be formulated as an I-O-weighted sum of producer prices allowing an effect of the import price (or other variables). This could worsen the empirical explanation, but the model would be more consistent.
- Export: There must be a way to estimate the effect of the Russian crisis besides a dummy, for example, divide the export (and GDP-index) in CIS and “other” and model the shift from CIS to “other”. This requires a further detailing of the export data, but would improve both the historical fit and the use of the model for analyses of foreign market developments.
- Import and intermediate: Part of the intermediate is imported and hence the import should depend on the demand for intermediate (and not only on private consumption). An important improvement would be to use an input-output table with separate rows for deliveries from import.

⁴¹ Public consumption (*CGRN*) is exogenous. The price on public consumption (*PCG*) is decreased by 1.3%. This is more than the average producer price (*PQ*) decrease because wages form a larger part of the production costs in the public service sector.

12. Appendix

12.1. List of Variables

Variable	Type	Description	Unit	Source/Computation
$a(i,j)$, $j = \text{Set1}; j = \text{Set2};$	const	Input-Output coefficient, from supply i to demand j		IO-97, BL
$a(j)_{im}$, $j = \text{Set1}$	const	Import in sector j as share of total import		IO-97, BL
$a(j)_{imp1}$, $j = \text{Set1}$	endo	Import share coefficients		$a(j)_{imp1} = a(j) \cdot \text{MRN}/\text{QR}(j)$
$\text{binr}(j)$, $j = \text{Set1}$	data	Intermediate share of production		IO-97, BL, $\text{binr}(j) = \text{INRj}/\text{QRj}$
CA	endo	Current account balance	Mill. Litas, current prices	Balance of payment, BL
CAPRT	endo	Total capital stock	Mill. Litas, constant prices	
CGEXV	data	National budget expenditure	1000 Litas, current prices	Ministry of Finance
CGREV	endo	National budget revenue	Mill. Litas, current prices	
CGREVP	endo	National budget revenue from corporate profits	Mill. Litas, current prices	
CGREVS	endo	National budget revenue from sectors	Mill. Litas, current prices	
CGREVV	endo	National budget revenue from VAT	Mill. Litas, current prices	
CGREVVW	endo	National budget revenue from personal income	Mill. Litas, current prices	
CGRN	exo	Government consumption expenditure	Mill. Litas, constant prices	National accounts, SL
CGSEOV	exo	SSSF expenditure subtracted by total pensions	1000 Litas, current prices	$\text{CGSEOV} = \text{CGSEV} - 3 \cdot \text{pens} \cdot \text{pensnr}$
CGSEV	endo	SSSF fund budget expenditure	1000 Litas, current prices	SSSF
CGV	endo	Government consumption expenditure	Mill. Litas, current prices	National accounts, SL
CRN	endo	Household consumption	Mill. Litas, constant prices	National accounts, SL
CV	endo	Household consumption expenditure	Mill. Litas, current prices	National accounts, SL
D98q2	exo	Dummy in the equation for investments in dwellings		Dummy, 1998q2=1, else 0
Delta	const	Depreciation rate		Delta = 0.025
DI	endo	Disposable income	Mill. Litas, current prices	See doc.
Dmaz	data	Privatisation of "Mazeikiu nafta" and "Lietuvos dujos"		Dummy, 2002q2=1, else 0
Dtel	data	Privatisation of "Lietuvos Telekomas"		Dummy, 1998q3=1, else 0
DumPCen	exo	Population census		Dummy, 1 after 2000q1, else 0
DumRC	exo	Crisis in Russia		Dummy, 1 after 1998q3, else 0
FDI	exo	Foreign direct investment	Mill. Litas, current prices	Balance of payment, BL
GDEBT	data	Total government debt	Mill. Litas, current prices	Ministry of Finance
GDEF	endo	National budget deficit	1000 Litas	Ministry of Finance
GDP	endo	GDP	Mill. Litas, constant prices	National accounts, SL
$\text{GDP}(j)$, $j = \text{Set1}$	endo	Gross value added	Mill. Litas, constant prices	National accounts, SL
$\text{GDP}(w)$, $w = \text{Set3}$	data	GDP in country w based on yearly data from IMF	1995=1	IMF
GDPPRI	endo	Total gross value added in private sector	Mill. Litas, constant prices	$\text{GDPPRI} = \text{GDPT} - \text{GDPS4}$
GDPT	endo	Total gross value added in sectors	Mill. Litas, constant prices	$\text{GDPT} = \text{SUM}(\text{GDP}(j))$
GDPV	endo	GDP	Mill. Litas, current prices	$\text{GDP} \cdot \text{expenditure.XLS}$
$\text{GDPV}(j)$, $j = \text{Set1}$	data	GVA in sectors	Mill. Litas, current prices	GDPQIN.XLS
GDPVT	endo	Total gross value added in sectors	Mill. Litas, current prices	SL
GDPwr	exo	GDP index for export market	1995=1	Weighted average of $\text{GDP}(w)$
INBAL	exo	Income	Mill. Litas, current prices	Balance of payment, BL
INDT	data	Taxes on products minus subsidies on products	Mill. Litas, constant prices	National accounts, SL
INDTV	data	Taxes on products minus subsidies on products	Mill. Litas, current prices	National accounts, SL
$\text{INR}(j)$, $j = \text{Set1}$	endo	Input (intermediate in sector j)	Mill. Litas, constant prices	SL, $\text{INR} = \text{QR} - \text{GDP}$
INRT	endo	Input total	Mill. Litas, constant prices	SL, $\text{INRT} = \text{SUM}(\text{INR}(j))$
$\text{INV}(j)$, $j = \text{Set1}$	data	Input	Mill. Litas, current prices	SL, $\text{INV} = \text{QV} - \text{GDPV}$
INVT	endo	Input total	Mill. Litas, current prices	SL, $\text{INVT} = \text{SUM}(\text{INV}(j))$
$\text{IR}(j)$, $j = \text{Set1}$	endo	Capital investment in sectors	Mill. Litas, constant prices	SL, $\text{IR}(j) = (\text{IV}(j)/\text{PI})/1000$
IRH	endo	Capital investment in dwellings	Mill. Litas, constant prices	SL, $\text{IRH} = (\text{IVH}/\text{PI})/1000$
IRN	data	Gross fixed capital formation	Mill. Litas, constant prices	National accounts, SL
IRN1	endo	Gross domestic investment	Mill. Litas, constant prices	National accounts, SL
IRT	endo	Total capital investment in sectors	Mill. Litas, constant prices	SL, $\text{IRT} = \text{SUM}(\text{IR}(j))$, $j = \text{Set1}$
IRTH	endo	Total capital investment	Mill. Litas, constant prices	SL, $\text{IRTH} = \text{IRT} + \text{IRH}$
IV	data	Gross fixed capital formation	Mill. Litas, current prices	National accounts, SL
$\text{IV}(j)$, $j = \text{Set1}$	data	Capital investment in sectors	1000 Litas, current prices	National accounts, SL
IV1	data	Gross domestic investment	Mill. Litas, current prices	National accounts, SL
IVT	data	Capital investment	Mill. Litas, current prices	SL, $\text{IVT} = \text{SUM}(\text{IV}(j))$, $j = \text{Set1}$
LN	endo	Employed people	1000 persons	SL
$\text{LN}(j)$, $j = \text{Set1}$	endo	Employed (who work the whole work day)	1000 persons	SL
LNPRI	endo	Employed (who work the whole work day) Private sector	1000 persons	$\text{LNPRI} = \text{SUM}(\text{LN}(j)) - \text{LNS4}$
LNT	endo	Employed (who work the whole work day) Total	1000 persons	$\text{LNT} = \text{SUM}(\text{LN}(j))$
LS	endo	Labour force	1000 persons	SL, LNWP.XLS
MRN	endo	Imports of goods and services	Mill. Litas, constant prices	SL, $\text{GDP} \cdot \text{expenditure.xls}$
MV	data	Imports of goods and services	Mill. Litas, current prices	SL, $\text{GDP} \cdot \text{expenditure.xls}$
NT	exo	Current transfers, balance	Mill. Litas, current prices	Balance of payment, BL
NTMIN	exo	Nontaxable minimal wage	Litas, current prices	Ministry of Finance

Variable	Type	Description	Unit	Source/Computation
PC	endo	Consumer price	1995=1	PC=CV/CRN
PCG	endo	Price on public consumption	1995=1	PCG=CGV/CGRN
PENS	endo	Average monthly pension	Litas, current prices	SSSF
PENSNR	exo	Number of pensioners	1000 persons	SSSF
PGDP	endo	GDP price	1995=1	PGDP=GDPV/GDP
PGDP(j), j=Set1	data	GDP price in sector j	1995=1	PGDP(j)=GDPV(j)/GDP(j)
PI	endo	Aggregated investment price	1995=1	PI=IV/IRN
PIN(j), j=Set1	endo	Price on intermediate in sector j	1995=1	PIN(j)=INV(j)/INR(j)
PINT	endo	Average price on intermediate	1995=1	PINT = INVT/INRT
PM	exo	Import price	1995=1	PM = MV/MRN
POP	exo	Population	1000 persons	SL
PQ	endo	Output price	1995=1	PQ=QVT/QRT
PQ(j), j=Set1	endo	Output price	1995=1	PQ(j)=QV(j)/QR(j)
PQEX	endo	Producer price used in equation for PX	1995=1	See doc.
PQM	endo	Output price in manufacturing	1995=1	PQM=QVM/QRM
PQS	endo	Output price in service	1995=1	PQS=QVS/QRS
PQUC(j), j=Set1	endo	Unit cost		See doc.
PROF	endo	Profit	Mill. Lit. current prices	See doc.
Pw(j), j=Set4	exo	CPI-index in country j		IMF
Pwr(j), j=Set4	endo	World market price j in Lit. current prices	1995=1	See doc.
PX	endo	Export price	1995=1	PX = XV/XRN
Q(j), j=2,3,4	exo	Quarterly dummies		Q2=1 in 2. quarter, else zero
Q4dirh	exo	Modified 4th quarter dummy (0 in 1998 and 1999)		disables Q4 after Russian crisis
QR(j), j=Set1	endo	Gross domestic production in sector j	Mill. Lit. constant prices	SL
QRM	endo	Production in manufacturing	Mill. Lit. constant prices	QRM = QRM1+QRM2+QRM3+QRM4
QRS	endo	Production in service sector	Mill. Lit. constant prices	QRS = QRS1+QRS2+QRS3+QRS4
QRT	endo	Gross domestic production	Mill. Lit. constant prices	SL, QRT = SUM(QR(j))
QV(j), j=Set1	data	Gross domestic production in sector j	Mill. Lit. current prices	SL
QVT	endo	Gross domestic production	Mill. Lit. current prices	SL, QVT = SUM(QV(j))
RA	exo	Average annual interest rates on loans in litas	%	BL
REER(j), j=Set4	exo	Real Effective Exchange Rate for j	Litas vs other currencies	BL
SSC	exo	Social security contribution rate	rate	SSSF
SSCIN	endo	SSSF revenue	Mill. Lit. current prices	See doc.
T	exo	Time index, quarterly		1995q1 = 1
TC	exo	Tax rate on profit	rate	Ministry of Finance
tcbase	exo	Correction factor for tax on profit		See doc.
TL	exo	Wage tax rate	rate	Ministry of Finance
TP	exo	Rate of taxes minus subsidies on products	rate	See doc.
U	endo	Unemployment rate	rate	Labour Exchange
VAT	exo	VAT rate	rate	Ministry of Finance
VMV	data	Changes in inventories	Mill. Lit. current prices	National accounts, SL
WMP	endo	World market price	1995=1	See doc.
workhour	exo	Average hours of working pr. week	hours	workhour = (LNT*40)/LN
WPRI	endo	Average monthly gross earnings in privat sector	Litas, current prices	SL
WPUB	endo	Average monthly gross earnings in public sector	Litas, current prices	SL
WSUM	endo	Wage sum	Mill. Lit. current prices	See doc.
XRN	endo	Exports of goods and services	Mill. Lit. constant prices	Balance of payment, BL
XV	data	Exports of goods and services	Mill. Lit. current prices	Balance of payment, BL

Set1={A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4}

Set2={A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4,Cp,IR,Cg,Ex}

Set3={UKI,LAT,GER,RUS,POL,DEN,BER,USA,SWE,UKR,FRA,EST,NET,ITA,BEL}

Set4={EU,CE,CI}

Type: endo (endogenous variable in the model), exo (exogenous variable in the model), const (constant coefficient), data (additional variable used in data generation)

Source: BL=Bank of Lithuania; SL=Statistics Lithuania; SSSF=State Social Security Fund; IMF=International Monetary Fund

12.2. Input-Output Matrix

Table 28 Input-Output Table 12 Sectors, Deliveries in mill. Litas (1997)

	SUPPLY	Import	Output	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4	Interm	Cp	I	Cg	X	USE
A	9356	1306	8049	361	0	0	0	0	3904	5	2	221	5	2	0	4501	2548	50	0	2257	9356
MN	347	0	347	15	14	7	61	1	2	0	115	0	28	0	0	243	9	6	0	88	347
E	8215	3706	4509	215	15	1805	266	130	408	46	79	327	721	57	284	4351	1407	5	0	2451	8215
M1	8379	5475	2904	315	8	122	384	420	269	38	1311	310	134	0	350	3662	641	794	0	3281	8379
M2	8541	5813	2728	165	25	120	107	483	392	50	85	219	411	10	0	2068	730	3426	0	2317	8541
M3	16039	3977	12063	118	2	22	55	99	595	43	123	865	120	60	0	2101	9023	159	0	4756	16039
M4	1110	358	752	10	0	4	5	8	14	49	2	2	4	2	0	100	651	5	0	354	1110
C	5704	299	5405	69	3	18	43	31	134	8	354	77	20	50	800	1606	411	3378	0	309	5704
S1	11487	1457	10030	2041	90	41	581	401	1444	143	20	1029	143	243	0	6175	2797	259	0	2256	11487
S2	7847	1613	6234	464	22	29	261	157	525	41	608	4	1206	161	376	3854	681	1379	0	1933	7847
S3	5027	466	4561	262	10	292	100	79	210	30	61	429	148	681	1628	3930	89	561	0	447	5027
S4	9768	9	9759	1	0	2	2	2	2	1	0	0	0	0	169	178	1006	155	8429	0	9768
Intermedi	91818	24478	67340	4036	139	2462	1864	1811	7900	453	2760	3483	2940	1265	3607	32770	19991	10176	8429	20451	91818
Wages&Salaries				547	38	685	390	474	1556	103	1294	1623	1037	731	4002	12479					
Soc. security				146	11	201	113	137	452	30	371	476	313	216	1148	3614					
Capital				201	34	599	182	124	419	21	142	363	704	306	689	3782					
Insurance				0	1	5	5	2	10	1	0	3	0	0	0	25					
Taxes				-9	33	131	37	35	129	8	72	360	13	41	30	880					
Surplus				3128	41	432	318	147	1606	139	766	3726	1226	2002	284	13816					
TOTAL VALUE ADDED				4013	157	2047	1040	917	4163	299	2645	6547	3293	3296	6152	34570					
OUTPUT				8049	347	4509	2904	2728	12063	752	5405	10030	6234	4561	9759	67341					

Table 29 Input-Output Coefficients 12 Sectors 1997

	A	MN	E	M1	M2	M3	M4	C	S1	S2	S3	S4	Interm	Cp	I	CG	X	M/Q	M ₁ /M
A	0.045	0.000	0.000	0.000	0.000	0.324	0.007	0.000	0.022	0.001	0.001	0.000	0.067	0.127	0.005	0.000	0.110	0.162	0.053
MN	0.002	0.041	0.001	0.021	0.001	0.000	0.001	0.021	0.000	0.004	0.000	0.000	0.004	0.000	0.001	0.000	0.004	0.000	0.000
E	0.027	0.044	0.400	0.092	0.048	0.034	0.061	0.015	0.033	0.116	0.012	0.029	0.065	0.070	0.000	0.000	0.120	0.822	0.151
M1	0.039	0.023	0.027	0.132	0.154	0.022	0.050	0.243	0.031	0.022	0.000	0.036	0.054	0.032	0.078	0.000	0.160	1.886	0.224
M2	0.020	0.071	0.027	0.037	0.177	0.033	0.067	0.016	0.022	0.066	0.002	0.000	0.031	0.037	0.337	0.000	0.113	2.131	0.237
M3	0.015	0.006	0.005	0.019	0.036	0.049	0.057	0.023	0.086	0.019	0.013	0.000	0.031	0.451	0.016	0.000	0.233	0.330	0.162
M4	0.001	0.000	0.001	0.002	0.003	0.001	0.065	0.000	0.000	0.001	0.000	0.000	0.001	0.033	0.000	0.000	0.017	0.476	0.015
C	0.009	0.009	0.004	0.015	0.011	0.011	0.010	0.065	0.008	0.003	0.011	0.082	0.024	0.021	0.332	0.000	0.015	0.055	0.012
S1	0.254	0.260	0.009	0.200	0.147	0.120	0.190	0.004	0.103	0.023	0.053	0.000	0.092	0.140	0.025	0.000	0.110	0.145	0.060
S2	0.058	0.063	0.006	0.090	0.057	0.044	0.054	0.113	0.000	0.194	0.035	0.038	0.057	0.034	0.136	0.000	0.095	0.259	0.066
S3	0.033	0.028	0.065	0.034	0.029	0.017	0.040	0.011	0.043	0.024	0.149	0.167	0.058	0.004	0.055	0.000	0.022	0.102	0.019
S4	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.017	0.003	0.050	0.015	1.000	0.000	0.001	0.000
Intermediate	0.501	0.546	0.546	0.642	0.664	0.655	0.602	0.511	0.347	0.472	0.277	0.370	0.487	1.000	1.000	1.000	1.000	0.363	1.000
Wages&Salaries	0.068	0.109	0.152	0.134	0.174	0.129	0.137	0.239	0.162	0.166	0.160	0.410	0.185						
Soc security	0.018	0.031	0.045	0.039	0.050	0.037	0.040	0.069	0.047	0.050	0.047	0.118	0.054						
Capital	0.025	0.098	0.133	0.063	0.045	0.035	0.027	0.026	0.036	0.113	0.067	0.071	0.056						
Insurance	0.000	0.002	0.001	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000						
Taxes	-0.001	0.096	0.029	0.013	0.013	0.011	0.010	0.013	0.036	0.002	0.009	0.003	0.013						
Surplus	0.389	0.119	0.096	0.110	0.054	0.133	0.184	0.142	0.371	0.197	0.439	0.029	0.205						
Value Added	0.499	0.454	0.454	0.358	0.336	0.345	0.398	0.489	0.653	0.528	0.723	0.630	0.513						
OUTPUT	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						

12.3. Private Consumption, Alternative Estimations

In this section, we present three different estimations of the equation for private consumption:

$$\log(Cp^*) = \alpha_0 + \alpha_1 \cdot \log(Y/P_C) + \lambda_2 \cdot Q_2 + \lambda_3 \cdot Q_3 + \lambda_4 \cdot Q_4 \quad (97)$$

$$\begin{aligned} \text{Dlog}(Cp) = & \beta_1 \text{Dlog}(Y/P_C) + \beta_2 \text{D}(i) + \beta_3 \text{D}(U) + \beta_4 \text{Dlog}(P_C) \\ & + \beta_0 [\log(Cp^*) - \log(Cp_{-1})] \end{aligned} \quad (98)$$

It was not possible to estimate a significant negative effect on changes in the unemployment rate (U), so we restrict the parameter to zero in all the estimations ($\beta_3 = 0$).

In the first estimation, all parameters are estimated simultaneously. In the second estimation, the long-term equation is firstly estimated and then the short-term equation is estimated contingent to the long-term coefficients (two-step estimation). In the third estimation, the long-term marginal income elasticity (α_1) is restricted to one. The three estimation results are presented in Table 30.

Table 30 Three Estimations of Private Consumption

No.	α_0	α_1	λ_2	λ_3	λ_4	β_0	β_1	β_2	β_3	β_4	R^2
1	3.253 [4.04]	0.627 [6.74]	-0.019 [-0.71]	0.050 [1.01]	-0.208 [-2.23]	0.428 [3.57]	0.189 [2.21]	-0.008 [-2.03]	0 *	-0.955 [-4.02]	0.957
2	1.726 [40.20]	0.806 *	-0.012 [-0.36]	0.069 [1.07]	-0.268 [-2.68]	0.351 [2.97]	0.232 [2.68]	-0.010 [-2.58]	0 *	-0.666 [-3.55]	0.950
3	0.135 [1.23]	1 *	0.141 [0.30]	0.141 [0.97]	-0.600 [-1.50]	0.185 [1.84]	0.219 [1.84]	-0.013 [-3.24]	0 *	-0.469 [-2.37]	0.939

Estimation period 1995q2-2002q2. t-values in []. * Restricted parameter.

The long-term marginal propensity to consume out of income is in the first estimation very small ($\alpha_1 = 0.63$), and the short-run propensity is even smaller ($\beta_1 = 0.19$). If disposable income (Y) is permanently increased with 1%, private consumption (Cp) increases only by 0.19% in the first quarter and with 0.63% in the long-run.

Looking at the estimated price effect in the first estimation, if the price on private consumption (P_C) is permanently increased by 1%, private consumption is in the long-run decreased by 0.63% (α_1), because real disposable income (Y/P_C) is decreased by 1%. But private consumption is in the first quarter decreased by 1.1% ($-\beta_1 + \beta_4$). If real consumption is decreased by 1% (and hence consumption expenditure $C \cdot P_C$ is unchanged), this tells us that consumers in Lithuania have in the short-run a very strict budget limit. However, with this estimation, real consumption decreases by more than 1% – and consumption expenditure is decreased by 0.1%; this seems unreasonable.

Therefore, in the third estimation, we estimate the consumption equations restricting the long-term marginal propensity to consume to unity, meaning that real consumption is a constant share of the real disposable income ($\alpha_1 = 1$). The degree of explanation (R^2) is decreased slightly from 0.957 to 0.939. The price elasticity is -0.69 in the first quarter ($-\beta_1 + \beta_4$) and -1.00 in the long-run (α_1). The problematic surrounding this estimation is that the error correction parameter (β_0) is decreased from 0.43 to 0.19, implying that adjustment towards the equilibrium relation is slow.

In the second estimation, we commence by only estimating the long-term relation (97). The long-run marginal propensity to consume is estimated to 0.81 (α_1). This parameter is then fixed and the dynamic adjustment (98) is estimated. The degree of explanation is only decreased from 0.957 to 0.950. The short-run marginal propensity to consume is about the same as in the other estimations ($\beta_1 = 0.2$). The long-run price elasticity is -0.81 , and the short-run price elasticity is -0.89 . This means that consumers have in the short-run a stricter budget restriction, whereas there are in the longer run wider possibilities to distribute income and consumption more equally between quarters. The adjustment is a bit slower than in the first estimation ($\beta_0 = 0.35$).

Due to the above considerations, we choose to use the second estimation in the model.

The effects of changing the exogenous variables in the three equations for private consumption are shown in the following figures.

Figure 61 shows the percentage change in private consumption where disposable income is permanently increased by 1%; the straight line is the effect by using estimation 1, the dotted line is estimation number 2, and the circled line is estimation 3.⁴² The long-term change in the private consumption differs between 0.6% (estimation 1) and 1% (estimation 3). We can see that the adjustment is much slower in the third estimation than the two others.

Figure 61 Percentage Change in Private Consumption, Disposable Income + 1%

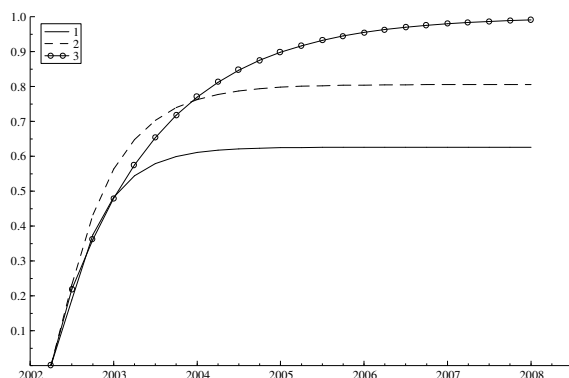
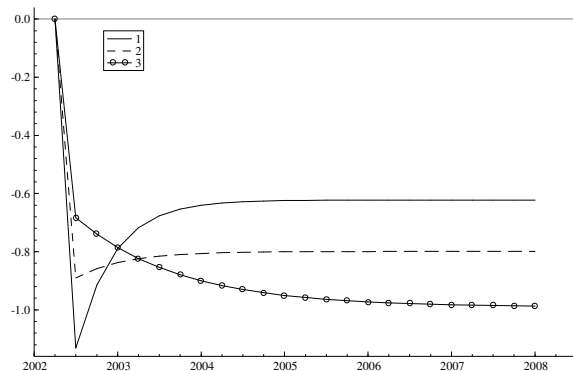


Figure 62 shows the effect on the private consumption when the consumer price is permanently increased by 1%. The long-term effect differs between -0.6% (estimation 1) to -1.0% (estimation 3). The greatest difference between the estimations is the short-term effect of a price increase on private consumption. There is in the first and second estimation a larger effect in the first quarters than in the long-run – and this effect is in the first estimation unacceptably high, as explained above.

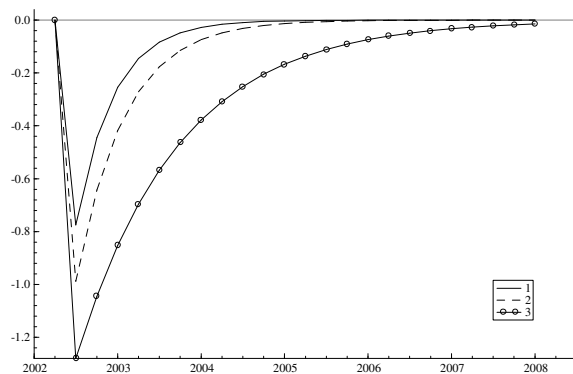
⁴² Firstly, equation (97) and (98) is simulated in the period 2002q3 to 2008q1 with an exogenous forecast of Y_d , P_C , and i to give a baseline scenario. Second, one of the exogenous variables, e.g. Y_d , is increased by 1% in the forecast period, and the two equations are simulated again. Third, we calculate the percentage change from the baseline scenario in the real private consumption (the multiplier).

Figure 62 Percentage Change in Private Consumption, Consumer Price + 1 %



Finally, we show in Figure 63 the effect of a 1% increase in the interest rate (i), e.g., from 5% to 6%. There is in the long-run no effect on the private consumption. The first quarter, real consumption is increased by $100 \cdot \beta_2 \%$. The effect is almost the same in the three estimations (from -0.8% to -1.3%). The adjustment towards zero is determined by the error correction parameter (β_0), and is quite slow in the third estimation.

Figure 63 Percentage Change in Private Consumption, Interest Rate + 1



12.4. Calculation of World Market Variables

Lithuania's 14 main foreign trade partners are: United Kingdom (uki), Latvia (lat), Germany (ger), Russia (rus), Poland (pol), Denmark (den), Belarus (ber), USA (usa), Sweden (swe), Ukraine (ukr), France (fra), Estonia (est), Netherlands (net), Italy (ita), and Belgium (bel). In 2001, export to other countries accounts for 11.4%. Source: Statistical Yearbook 2002 table 23.3.

Table 31 Calculation of GDP World

```
? Data for GDPworld based on yearly data from IMF
? SOURCE is: http://www.imf.org/external/pubs/ft/weo/2003/01/data/index.htm
? Annual percent change Gross domestic product, constant prices IMF

? As weights are we using Export shares in 2001, 11.4% to other countries
GENR GDP_w = (0.138/(1-0.114))*GDP_uki
              + (0.126/(1-0.114))*GDP_lat
              + (0.126/(1-0.114))*GDP_ger
              + (0.110/(1-0.114))*GDP_rus
              + (0.063/(1-0.114))*GDP_pol
              + (0.045/(1-0.114))*GDP_den
              + (0.039/(1-0.114))*GDP_ber
              + (0.038/(1-0.114))*GDP_usa
              + (0.037/(1-0.114))*GDP_swe
              + (0.034/(1-0.114))*GDP_ukr
              + (0.033/(1-0.114))*GDP_fra
              + (0.032/(1-0.114))*GDP_est
              + (0.029/(1-0.114))*GDP_net
              + (0.020/(1-0.114))*GDP_ita
              + (0.016/(1-0.114))*GDP_bel;
```

Table 32 Calculation of World Market Price

```
? Data for 'world market price' based on yearly data from IMF
? SOURCE is: http://www.imf.org/external/pubs/ft/weo/2003/01/data/index.htm
? Annual percent change in pcpi inflation IMF

? Since we have exchange rate for EU, CE and CIS we aggregate to three price index
? As weights are we using Export shares in 2001, (3.8% to USA and 11.4% to other countries)
? (same as for GDPworld)

GENR weight_eu = 0.138+0.126+0.045+0.037+0.033+0.029+0.020+0.016;
GENR Pweu = (0.138/weight_eu)*P_uki
            + (0.126/weight_eu)*P_ger
            + (0.045/weight_eu)*P_den
            + (0.037/weight_eu)*P_swe
            + (0.033/weight_eu)*P_fra
            + (0.029/weight_eu)*P_net
            + (0.020/weight_eu)*P_ita
            + (0.016/weight_eu)*P_bel;

GENR weight_ce = 0.126+0.063+0.032;
GENR Pwce = (0.126/weight_ce)*P_lat
            + (0.063/weight_ce)*P_pol
            + (0.032/weight_ce)*P_est;

? The inflation in Belarus is extreme - so we leave it out of the index
GENR weight_ci = 0.110+0.034;
GENR Pwci = (0.110/weight_ci)*P_rus
            + (0.034/weight_ci)*P_ukr;

? World market prices in LTL (normalize to 1 in 1995:1)
DOT eu,ce,ci;
    GENR pwr. = (pw./reer.)/(pw.(1995:1)/reer.(1995:1));
ENDDOT;

? World market price (export and import market)
? Weights calculated using EU, CIS and CE shares of export in 2001 from Statistic Yearbook
? Import weights are almost the same
GENR wmp = 0.64*pwreu + 0.26*pwrci + 0.10*pwrce;
```

12.5. Model Equations

Table 33 Equations Formulated in TSP

<p>----- ? *** LITMOD.TSP *** -----</p>	
<p>----- ? *** EQUATIONS (Appendix 5) *** -----</p>	
<p>? *** HOUSEHOLDS ***</p>	
<p>? Disposable income IDENT Iddi DI = 0.003*((ntmin+(wpri-ntmin)*(1-TL))*LNpri + (ntmin+(wpub-ntmin)*(1-TL))*LNs4) + PROF*(1-TC*tcbase) + 0.00096*cgsev;</p>	
<p>? Private consumption FRML EQlcrn LRcrn = exp(1.72622 + 0.80637*log(di/pc) + 0.012419*Q2 + 0.068755*Q3 + -0.26771*Q4); FRML EQdlcrn crn = exp(log(crn(-1)) + 0.23186*(log((di/pc)/(di(-1)/pc(-1)))) + 0.35084*(log(LRcrn(-1)) - log(crn(-1))) + -0.0099280*(ra - ra(-1)) + 0.00000*(U-U(-1)) + -0.66647*log(pc/pc(-1)) + ADDJ*JDCRN); IDENT IDCv cv = crn*pc;</p>	
<p>? Investments in dwellings FRML EQlirh irh = exp(0.00000 + 0.56127*log(di(-1)/pc(-1)) + 0.00000*log(pgc) + -0.47906*D98q2 + 0.00000*Q2 + 0.00000*Q3 + 0.35042*Q4dirh + ADDJ*JLIRH);</p>	
<p>----- ? *** GOVERNMENT ***</p>	
<p>IDENT IDCgrevw cgrevw = 0.003*((wpri-ntmin)*lnpri+(wpub-ntmin)*lns4)*tl; IDENT IDCgrevp cgrevp = prof*tc*tcbase; IDENT IDCgrevv cgrevv = crn*pc*vat/(1+vat); IDENT IDCgrevs cgrevs = tp*inv; IDENT IDCgrev cgre = 1000*(cgrevp + cgrevw + cgrevv + cgrevs); IDENT IDsscin sscin = ssc*wsum; IDENT IDgdef GDEF = cgre - 1000*cgrn*pcg; FRML eqlpens pens = EXP(0.64058 + 0.70350*log(wpri) + -0.038229*Q2 + -0.053483*Q3 + -0.091575*Q4 + ADDJ*JLPENS); IDENT IDCgsev CGSEV = 3*pens*pensnr+CGSEOV; IDENT IDCgv CGV = CGRN*PCG;</p>	
<p>----- ? *** EXPORT ***</p>	
<p>FRML EQlrxn LRxn = exp(8.35456 + 1.57099*log(GDPwr) + -0.51381*log(px/wmp) + 0.00000*log(px) + 0.00000*log(wmp) + 0.00000*log(irt) + 0.00000*t + -0.14692*dumRC + 0.010090*Q2 + -0.16719*Q3 + -0.23015*Q4); FRML EQdlxn xrn = exp(log(xrn(-1))+0.00000*log(GDPwr/GDPwr(-1)) + 0.00000*(log(px/wmp)-log(px(-1)/wmp(-1))) + -1.12417*(log(px)-log(px(-1))) + 0.00000*(log(wmp)-log(wmp(-1))) + 0.00000*(log(irt)-log(irt(-1))) + -0.14692*(dumRC-dumRC(-1)) + -0.40528*(log(xrn(-1))-log(LRxrn(-1)))+ADDJ*JDXRN);</p>	
<p>----- ? *** IMPORT ***</p>	
<p>FRML EQlmrn LRmrn = exp(-5.98972 + 1.70862*log(CRN) + -0.80737*log(pm/pc) + -0.21182*dumrc + 0.00000*t + -0.092703*Q2 + -0.031128*Q3 + 0.059151*Q4);</p>	


```

FRML EQdlmrn mrn = exp(log(mrn(-1))+2.17533*(log(CRN)-log(CRN(-1))))
      + -1.36373*(log(pm/pc)-log(pm(-1)/pc(-1)))
      + -0.21182*(dumrc-dumrc(-1))
      + -0.87894*(log(mrn(-1))-log(LRmrn(-1)))+ADDJ*JDMRN);

?-----
? *** DOMESTIC PRODUCTION, INTERMEDIATE AND GDP ***

? Import share coefficients
IDENT IDaiA aAimpl = 0.05300 * MRN/QRA;
IDENT IDaiMN aMNIimpl = 0.00000 * MRN/QRMN;
IDENT IDaiE aEimpl = 0.15100 * MRN/QRE;
IDENT IDaiM1 aM1impl = 0.22400 * MRN/QRM1;
IDENT IDaiM2 aM2impl = 0.23700 * MRN/QRM2;
IDENT IDaiM3 aM3impl = 0.16200 * MRN/QRM3;
IDENT IDaiM4 aM4impl = 0.01500 * MRN/QRM4;
IDENT IDaiC aCimpl = 0.01200 * MRN/QRC;
IDENT IDaiS1 aS1impl = 0.06000 * MRN/QRS1;
IDENT IDaiS2 aS2impl = 0.06600 * MRN/QRS2;
IDENT IDaiS3 aS3impl = 0.01900 * MRN/QRS3;
IDENT IDaiS4 aS4impl = 0.00000 * MRN/QRS4;

? Domestic Production in sectors
FRML EQQRA QRA = (0.045000*QRA + 0.00000*QRMN + 0.00000*QRE + 0.00000*QRM1
      + 0.00000*QRM2 + 0.32400*QRM3 + 0.0070000*QRM4 + 0.00000*QRC
      + 0.022000*QRS1 + 0.0010000*QRS2 + 0.0010000*QRS3 + 0.00000*QRS4
      + 0.12700*CRN + 0.00000*CGRN + 0.0050000*IRN1 + 0.11000*XRN
      + (-232.41908-1252.81012--480.83547)*Q1
      + -232.41908*Q2 + 1252.81012*Q3 + -480.83547*Q4
      + 300.95109 + (-20.18309)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
      / (1 + aAimpl) + ADDJ*J_QRA;
FRML EQQRMN QRMN = (0.0020000*QRA + 0.041000*QRMN + 0.0010000*QRE + 0.021000*QRM1
      + 0.0010000*QRM2 + 0.00000*QRM3 + 0.0010000*QRM4 + 0.021000*QRC
      + 0.00000*QRS1 + 0.0040000*QRS2 + 0.00000*QRS3 + 0.00000*QRS4
      + 0.00000*CRN + 0.00000*CGRN + 0.0010000*IRN1 + 0.0040000*XRN
      + (-11.89810-3.29926-0.53197)*Q1
      + 11.89810*Q2 + 3.29926*Q3 + 0.53197*Q4
      + -22.89928 + (2.09746)*(t*D + t(2002:2)*(1-D)) + 9.96477*dumRC)
      / (1 + aMNIimpl) + ADDJ*J_QRMN;
FRML EQQRE QRE = (0.027000*QRA + 0.044000*QRMN + 0.40000*QRE + 0.092000*QRM1
      + 0.048000*QRM2 + 0.034000*QRM3 + 0.061000*QRM4 + 0.015000*QRC
      + 0.033000*QRS1 + 0.11600*QRS2 + 0.012000*QRS3 + 0.029000*QRS4
      + 0.070000*CRN + 0.00000*CGRN + 0.00000*IRN1 + 0.12000*XRN
      + (-106.97237--275.53441-191.86185)*Q1
      + -106.97237*Q2 + -275.53441*Q3 + 191.86185*Q4
      + 481.84092 + (-14.46048)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
      / (1 + aEimpl) + ADDJ*J_QRE;
FRML EQQRM1 QRM1 = (0.039000*QRA + 0.023000*QRMN + 0.027000*QRE + 0.13200*QRM1
      + 0.15400*QRM2 + 0.022000*QRM3 + 0.050000*QRM4 + 0.24300*QRC
      + 0.031000*QRS1 + 0.022000*QRS2 + 0.00000*QRS3 + 0.036000*QRS4
      + 0.032000*CRN + 0.00000*CGRN + 0.078000*IRN1 + 0.16000*XRN
      + (-31.09492--156.96695-34.28156)*Q1
      + 31.09492*Q2 + -156.96695*Q3 + 34.28156*Q4
      + 66.72255 + (6.12465)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
      / (1 + aM1impl) + ADDJ*J_QRM1;
FRML EQQRM2 QRM2 = (0.020000*QRA + 0.071000*QRMN + 0.027000*QRE + 0.037000*QRM1
      + 0.17700*QRM2 + 0.033000*QRM3 + 0.067000*QRM4 + 0.016000*QRC
      + 0.022000*QRS1 + 0.066000*QRS2 + 0.0020000*QRS3 + 0.00000*QRS4
      + 0.037000*CRN + 0.00000*CGRN + 0.33700*IRN1 + 0.11300*XRN
      + (-20.28828--225.17120-96.66472)*Q1
      + -20.28828*Q2 + -225.17120*Q3 + 96.66472*Q4
      + 0.00000 + (14.90333)*(t*D + t(2002:2)*(1-D)) + -70.41489*dumRC)
      / (1 + aM2impl) + ADDJ*J_QRM2;
FRML EQQRM3 QRM3 = (0.015000*QRA + 0.0060000*QRMN + 0.0050000*QRE + 0.019000*QRM1
      + 0.036000*QRM2 + 0.049000*QRM3 + 0.057000*QRM4 + 0.023000*QRC
      + 0.086000*QRS1 + 0.019000*QRS2 + 0.013000*QRS3 + 0.00000*QRS4
      + 0.45100*CRN + 0.00000*CGRN + 0.016000*IRN1 + 0.23300*XRN
      + (-151.54251--25.26468--114.61742)*Q1
      + 151.54251*Q2 + -25.26468*Q3 + -114.61742*Q4
      + -226.17461 + (9.92337)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
      / (1 + aM3impl) + ADDJ*J_QRM3;
FRML EQQRM4 QRM4 = (0.0010000*QRA + 0.00000*QRMN + 0.0010000*QRE + 0.0020000*QRM1
      + 0.0030000*QRM2 + 0.0010000*QRM3 + 0.065000*QRM4 + 0.00000*QRC
      + 0.00000*QRS1 + 0.0010000*QRS2 + 0.00000*QRS3 + 0.00000*QRS4
      + 0.033000*CRN + 0.00000*CGRN + 0.00000*IRN1 + 0.017000*XRN
      + (-0.00000-0.00000-0.00000)*Q1
      + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
      + -40.57898 + (4.85882)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
      / (1 + aM4impl) + ADDJ*J_QRM4;
FRML EQQRS1 QRS1 = (0.25400*QRA + 0.26000*QRMN + 0.0090000*QRE + 0.20000*QRM1

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+ 0.14700*QRM2 + 0.12000*QRM3 + 0.19000*QRM4 + 0.0040000*QRC
+ 0.10300*QRS1 + 0.023000*QRS2 + 0.053000*QRS3 + 0.00000*QRS4
+ 0.14000*CRN + 0.00000*CGRN + 0.025000*IRN1 + 0.11000*XRN
+ (-55.28066--375.74757-260.16956)*Q1
+ 55.28066*Q2 + -375.74757*Q3 + 260.16956*Q4
+ -301.76883 + (0.00000)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
/(1 + aS1imp1) + ADDJ*J_QRS1;
FRML EQQRS2 QRS2 = (0.058000*QRA + 0.063000*QRMN + 0.0060000*QRE + 0.090000*QRM1
+ 0.057000*QRM2 + 0.044000*QRM3 + 0.054000*QRM4 + 0.11300*QRC
+ 0.0080000*QRS1 + 0.19400*QRS2 + 0.035000*QRS3 + 0.038000*QRS4
+ 0.034000*CRN + 0.00000*CGRN + 0.13600*IRN1 + 0.095000*XRN
+ (-4.21683--183.80561-50.54916)*Q1
+ -4.21683*Q2 + -183.80561*Q3 + 50.54916*Q4
+ -19.13872 + (0.00000)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
/(1 + aS2imp1) + ADDJ*J_QRS2;

FRML EQQRC QRC = (0.0090000*QRA + 0.0090000*QRMN + 0.0040000*QRE + 0.015000*QRM1
+ 0.011000*QRM2 + 0.011000*QRM3 + 0.010000*QRM4 + 0.065000*QRC
+ 0.0080000*QRS1 + 0.0030000*QRS2 + 0.011000*QRS3 + 0.082000*QRS4
+ 0.021000*CRN + 0.00000*CGRN + 0.33200*IRN1 + 0.015000*XRN
+ (-6.04974-84.18812-33.82486)*Q1
+ -6.04974*Q2 + 84.18812*Q3 + 33.82486*Q4
+ -379.72577 + (0.00000)*(t*D + t(2002:2)*(1-D)) + -33.04022*dumRC)
/(1+aCimp1)
+ 0.89006*(QRC(-1)
- ((0.0090000*QRA(-1) + 0.0090000*QRMN(-1) + 0.0040000*QRE(-1)
+ 0.015000*QRM1(-1) + 0.011000*QRM2(-1) + 0.011000*QRM3(-1)
+ 0.010000*QRM4(-1) + 0.065000*QRC(-1) + 0.0080000*QRS1(-1)
+ 0.0030000*QRS2(-1) + 0.011000*QRS3(-1) + 0.082000*QRS4(-1)
+ 0.021000*CRN(-1) + 0.00000*CGRN(-1) + 0.33200*IRN1(-1)
+ 0.015000*XRN(-1) + (-6.04974-84.18812-33.82486)*Q1(-1)
+ -6.04974*Q2(-1) + 84.18812*Q3(-1) + 33.82486*Q4(-1)
+ -379.72577 + (0.00000)*(t(-1)*D + t(2002:2)*(1-D))
+ -33.04022*dumRC(-1))
/(1+aCimp1))) + ADDJ*J_QRC;
FRML EQQRS3 QRS3 = (0.033000*QRA + 0.028000*QRMN + 0.065000*QRE + 0.034000*QRM1
+ 0.029000*QRM2 + 0.017000*QRM3 + 0.040000*QRM4 + 0.011000*QRC
+ 0.043000*QRS1 + 0.024000*QRS2 + 0.14900*QRS3 + 0.16700*QRS4
+ 0.0040000*CRN + 0.00000*CGRN + 0.055000*IRN1 + 0.022000*XRN
+ (-7.35035--64.45649--9.70221)*Q1
+ 7.35035*Q2 + -64.45649*Q3 + -9.70221*Q4
+ 0.00000 + (4.12386)*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC)
/(1+aS3imp1)
+ 0.31894*(QRS3(-1)
- ((0.033000*QRA(-1) + 0.028000*QRMN(-1) + 0.065000*QRE(-1)
+ 0.034000*QRM1(-1) + 0.029000*QRM2(-1) + 0.017000*QRM3(-1)
+ 0.040000*QRM4(-1) + 0.011000*QRC(-1) + 0.043000*QRS1(-1)
+ 0.024000*QRS2(-1) + 0.14900*QRS3(-1) + 0.16700*QRS4(-1)
+ 0.0040000*CRN(-1) + 0.00000*CGRN(-1) + 0.055000*IRN1(-1)
+ 0.022000*XRN(-1) + (-7.35035--64.45649--9.70221)*Q1(-1)
+ 7.35035*Q2(-1) + -64.45649*Q3(-1) + -9.70221*Q4(-1)
+ 0.00000 + (4.12386)*(t(-1)*D + t(2002:2)*(1-D))
+ 0.00000*dumRC(-1))
/(1+aS3imp1))) + ADDJ*J_QRS3;

FRML EQQRS4 QRS4 = (0.00000*QRA + 0.0010000*QRMN + 0.0010000*QRE + 0.0010000*QRM1
+ 0.0010000*QRM2 + 0.00000*QRM3 + 0.0010000*QRM4 + 0.00000*QRC
+ 0.00000*QRS1 + 0.00000*QRS2 + 0.00000*QRS3 + 0.017000*QRS4
+ 0.050000*CRN + 1.00000*CGRN + 0.015000*IRN1 + 0.00000*XRN
+ (-0.00000-0.00000-0.00000)*Q1
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
- (300.95109+-22.89928+481.84092+66.72255+0.00000+-226.17461+-40.57898
+ -379.72577+-301.76883+-19.13872+0.00000)
- (-20.18309+2.09746+-14.46048+6.12465+14.90333+9.92337+4.85882
+ 0.00000+0.00000+0.00000+4.12386)*(t*D + t(2002:2)*(1-D))
- (0.00000+9.96477+0.00000+0.00000+-70.41489+0.00000+0.00000
+ -33.04022+0.00000+0.00000+0.00000)*dumRC)
/(1+aS4imp1) + ADDJ*J_QRS4 ;

IDENT EQQRT QRT = QRA+QRMN+QRE+QRM1+QRM2+QRM3+QRM4+QRC+QRS1+QRS2+QRS3+QRS4;
IDENT EQQRM QRM = QRM1+QRM2+QRM3+QRM4;
IDENT EQQRS QRS = QRS1+QRS2+QRS3+QRS4;
IDENT IDQVT QVT = PQ*QRT;

? Intermediate in 12 sectors
FRML EQINRA INRA = (0.045000+0.0020000+0.027000+0.039000+0.020000+0.015000+0.0010000
+ 0.0090000+0.25400+0.058000+0.033000+0.00000)*QRA*1.20382
+ -0.37784 + -0.049624*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRA;

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FRML EQINRMN INRMN = (0.00000+0.041000+0.044000+0.023000+0.071000+0.0060000+0.00000
+0.0090000+0.26000+0.063000+0.028000+0.0010000)*QRMN*0.88901
+ 2.09809 + -0.24174*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.22315--1.09134-0.079829)*Q1 + -0.22315*Q2 + -1.09134*Q3 + 0.079829*Q4
+ ADDJ*J_INRMN;
FRML EQINRE INRE = (0.00000+0.0010000+0.40000+0.027000+0.027000+0.0050000+0.0010000
+0.0040000+0.0090000+0.0060000+0.065000+0.0010000)*QRE*1.36996
+ 28.22936 + 0.00000*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-11.28129--14.25805-8.41661)*Q1 + -11.28129*Q2 + -14.25805*Q3 + 8.41661*Q4
+ ADDJ*J_INRE;
FRML EQINRM1 INRM1 = (0.00000+0.021000+0.092000+0.13200+0.037000+0.019000+0.0020000
+0.015000+0.20000+0.090000+0.034000+0.0010000)*QRM1*1.08276
+ 1.32894 + -0.076148*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRM1;
FRML EQINRM2 INRM2 = (0.00000+0.0010000+0.048000+0.15400+0.17700+0.036000
+0.0030000+0.011000+0.14700+0.057000+0.029000+0.0010000)*QRM2*1.04295
+ 3.48263 + -0.086502*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRM2;
FRML EQINRM3 INRM3 = (0.32400+0.00000+0.034000+0.022000+0.033000+0.049000+0.0010000
+0.011000+0.12000+0.044000+0.017000+0.00000)*QRM3*1.06494
+ 0.00000 + -0.39652*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRM3;
FRML EQINRM4 INRM4 = (0.0070000+0.0010000+0.061000+0.050000+0.067000+0.057000+0.065000
+0.0100000+0.19000+0.054000+0.040000+0.0010000)*QRM4*1.15395
+ 0.36723 + -0.017645*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRM4;
FRML EQINRC INRC = (0.00000+0.021000+0.015000+0.24300+0.016000+0.023000+0.00000
+0.065000+0.0040000+0.11300+0.011000+0.00000)*QRC*1.15064
+ 0.023108 + 0.00000*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRC;
FRML EQINRS1 INRS1 = (0.022000+0.00000+0.033000+0.031000+0.022000+0.086000+0.00000
+0.0080000+0.10300+0.00000+0.043000+0.00000)*QRS1*1.49473
+ -232.01783 + -7.36681*(t*D + t(2002:2)*(1-D)) + 63.34682*dumRC
+ (-3.98572--26.09309--10.49328)*Q1 + -3.98572*Q2 + -26.09309*Q3 + -10.49328*Q4
+ ADDJ*J_INRS1;
FRML EQINRS2 INRS2 = (0.0010000+0.0040000+0.11600+0.022000+0.066000+0.019000+0.0010000
+0.0030000+0.023000+0.19400+0.024000+0.00000)*QRS2*1.07990
+ -16.30147 + 0.00000*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRS2;
FRML EQINRS3 INRS3 = (0.0010000+0.00000+0.012000+0.00000+0.0020000+0.013000+0.00000
+0.011000+0.053000+0.035000+0.14900+0.00000)*QRS3*1.55535
+ -110.73537 + -0.32270*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-0.00000-0.00000-0.00000)*Q1 + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4
+ ADDJ*J_INRS3;
FRML EQINRS4 INRS4 = (0.00000+0.00000+0.029000+0.036000+0.00000+0.00000+0.00000+0.082000
+0.00000+0.038000+0.16700+0.017000)*QRS4*1.57352
+ -206.51272 + -4.62432*(t*D + t(2002:2)*(1-D)) + 0.00000*dumRC
+ (-43.65244-31.05534-2.40337)*Q1 + -43.65244*Q2 + 31.05534*Q3 + 2.40337*Q4
+ ADDJ*J_INRS4;
IDENT EQINRT INRT = INRA+INRMN+INRE+INRM1+INRM2+INRM3+INRM4+INRC+INRS1+INRS2+INRS3+INRS4;
IDENT EQINVT INVT = INRA*PINA+INRMN*PINMN+INRE*PINE+INRM1*PINM1+INRM2*PINM2+INRM3*PINM3
+INRM4*PINM4+INRC*PINC+INRS1*PINS1+INRS2*PINS2+INRS3*PINS3+INRS4*PINS4;

? GDP in 12 sectors (Gross Value Added)
IDENT EQGDPA GDPA = QRA - INRA;
IDENT EQGDPMN GDPMN = QRMN - INRMN;
IDENT EQGDPE GDPE = QRE - INRE;
IDENT EQGDPM1 GDPM1 = QRM1 - INRM1;
IDENT EQGDPM2 GDPM2 = QRM2 - INRM2;
IDENT EQGDPM3 GDPM3 = QRM3 - INRM3;
IDENT EQGDPM4 GDPM4 = QRM4 - INRM4;
IDENT EQGDPC GDPC = QRC - INRC;
IDENT EQGDPS1 GDPS1 = QRS1 - INRS1;
IDENT EQGDPS2 GDPS2 = QRS2 - INRS2;
IDENT EQGDPS3 GDPS3 = QRS3 - INRS3;
IDENT EQGDPS4 GDPS4 = QRS4 - INRS4;

IDENT EQGDPPRI GDPRI = GDPA+GDPMN+GDPE+GDPM1+GDPM2+GDPM3+GDPM4+GDPC+GDPS1+GDPS2+GDPS3;
IDENT EQGDPT GDPT = GDPRI + GDPS4;
IDENT EQGDPVT GDPVT = GDPT*PGDP;
IDENT IDGDP1 GDP = XRN - MRN + IRN1 + CRN + CGRN;
IDENT IDGDP2 GDPV = GDPVT + cgrevv;

? Current account balance

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IDENT IDCA      CA      = PX*XRN + INBAL + NT - PM*MRN;

?-----
? *** LABOUR MARKET ***

? Labour demand in sectors
FRML EQ1lnA LRlnA = exp(0.85524 + -0.023594*t + 1.00000*log(GDPA)
+ -0.32563*log(wpri*(1+ssc)/pqA)
+ -0.33856*dumPCen + 0.00000*dumPCen(-4)
+ -0.43086*Q2 + -1.55085*Q3 + -0.52764*Q4);
FRML EQd1lnA lnA = exp(log(lnA(-1))+0.00000*log(GDPA/GDPA(-1))
+ 0.00000*log((wpri*(1+ssc)/pqA)/(wpri(-1)*(1+ssc(-1))/pqA(-1)))
+ -0.33856*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.28378*(log(lnA(-1))-log(LRlnA(-1)))+ADDJ*JDLNA);
FRML EQ1lnMN LRlnMN = exp(-1.97092 + 0.00000*t + 1.00000*log(GDPMN)
+ 0.00000*log(wpri*(1+ssc)/pqMN)
+ 0.00000*dumPCen + -0.36759*dumPCen(-4)
+ -1.38954*Q2 + -2.00854*Q3 + 1.06137*Q4);
FRML EQd1lnMN lnMN = exp(log(lnMN(-1))+0.14664*log(GDPMN/GDPMN(-1))
+ 0.00000*log((wpri*(1+ssc)/pqMN)/(wpri(-1)*(1+ssc(-1))/pqMN(-1)))
+ 0.00000*(dumPCen-dumPCen(-1)) + -0.36759*(dumPCen(-4)-dumPCen(-5))
- 0.10000*(log(lnMN(-1))-log(LRlnMN(-1)))+ADDJ*JDLNMN);
FRML EQ1lnE LRlnE = exp(-1.75679 + 0.00000*t + 1.00000*log(GDPE)
+ 0.00000*log(wpri*(1+ssc)/pqE)
+ -0.031096*dumPCen + 0.00000*dumPCen(-4)
+ -0.14166*Q2 + -0.30197*Q3 + -0.36058*Q4);
FRML EQd1lnE lnE = exp(log(lnE(-1))+0.067238*log(GDPE/GDPE(-1))
+ 0.00000*log((wpri*(1+ssc)/pqE)/(wpri(-1)*(1+ssc(-1))/pqE(-1)))
+ -0.031096*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.10000*(log(lnE(-1))-log(LRlnE(-1)))+ADDJ*JDLNE);
FRML EQ1lnM1 LRlnM1 = exp(-1.93081 + -0.011917*t + 1.00000*log(GDPM1)
+ 0.00000*log(wpri*(1+ssc)/pqM1)
+ -0.10788*dumPCen + 0.00000*dumPCen(-4)
+ 0.17229*Q2 + 0.0034630*Q3 + 0.20950*Q4);
FRML EQd1lnM1 lnM1 = exp(log(lnM1(-1))+0.15236*log(GDPM1/GDPM1(-1))
+ 0.00000*log((wpri*(1+ssc)/pqM1)/(wpri(-1)*(1+ssc(-1))/pqM1(-1)))
+ -0.10788*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.25575*(log(lnM1(-1))-log(LRlnM1(-1)))+ADDJ*JDLNM1);
FRML EQ1lnM2 LRlnM2 = exp(-1.43274 + -0.027497*t + 1.00000*log(GDPM2)
+ 0.00000*log(wpri*(1+ssc)/pqM2)
+ -0.089059*dumPCen + 0.00000*dumPCen(-4)
+ 0.27439*Q2 + 0.26503*Q3 + 0.32514*Q4);
FRML EQd1lnM2 lnM2 = exp(log(lnM2(-1))+0.00000*log(GDPM2/GDPM2(-1))
+ 0.00000*log((wpri*(1+ssc)/pqM2)/(wpri(-1)*(1+ssc(-1))/pqM2(-1)))
+ -0.089059*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.19149*(log(lnM2(-1))-log(LRlnM2(-1)))+ADDJ*JDLNM2);
FRML EQ1lnM3 LRlnM3 = exp(1.46783 + 0.010748*t + 1.00000*log(GDPM3)
+ -0.44648*log(wpri*(1+ssc)/pqM3)
+ -0.10393*dumPCen + 0.00000*dumPCen(-4)
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQd1lnM3 lnM3 = exp(log(lnM3(-1))+0.10770*log(GDPM3/GDPM3(-1))
+ 0.00000*log((wpri*(1+ssc)/pqM3)/(wpri(-1)*(1+ssc(-1))/pqM3(-1)))
+ -0.10393*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.30154*(log(lnM3(-1))-log(LRlnM3(-1)))+ADDJ*JDLNM3);
FRML EQ1lnM4 LRlnM4 = exp(-1.42544 + -0.030116*t + 1.00000*log(GDPM4)
+ 0.00000*log(wpri*(1+ssc)/pqM4)
+ -0.11800*dumPCen + 0.00000*dumPCen(-4)
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQd1lnM4 lnM4 = exp(log(lnM4(-1))+0.10340*log(GDPM4/GDPM4(-1))
+ 0.00000*log((wpri*(1+ssc)/pqM4)/(wpri(-1)*(1+ssc(-1))/pqM4(-1)))
+ -0.11800*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.10992*(log(lnM4(-1))-log(LRlnM4(-1)))+ADDJ*JDLNM4);
FRML EQ1lnC LRlnC = exp(3.52200 + 0.00000*t + 1.00000*log(GDPC)
+ -0.76102*log(wpri*(1+ssc)/pqC)
+ -0.12245*dumPCen + 0.00000*dumPCen(-4)
+ -0.30027*Q2 + -0.22172*Q3 + 0.36252*Q4);
FRML EQd1lnC lnC = exp(log(lnC(-1))+0.62091*log(GDPC/GDPC(-1))
+ 0.00000*log((wpri*(1+ssc)/pqC)/(wpri(-1)*(1+ssc(-1))/pqC(-1)))
+ -0.12245*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.50893*(log(lnC(-1))-log(LRlnC(-1)))+ADDJ*JDLNC);
FRML EQ1lnS1 LRlnS1 = exp(-2.26274 + 0.00000*t + 1.00000*log(GDPS1)
+ 0.00000*log(wpri*(1+ssc)/pqS1)
+ -0.25166*dumPCen + 0.00000*dumPCen(-4)
+ -0.010624*Q2 + -0.13269*Q3 + 0.21444*Q4);
FRML EQd1lnS1 lnS1 = exp(log(lnS1(-1))+0.24686*log(GDPS1/GDPS1(-1))
+ 0.00000*log((wpri*(1+ssc)/pqS1)/(wpri(-1)*(1+ssc(-1))/pqS1(-1)))
+ -0.25166*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.44719*(log(lnS1(-1))-log(LRlnS1(-1)))+ADDJ*JDLNS1);
FRML EQ1lnS2 LRlnS2 = exp(-1.85818 + -0.016015*t + 1.00000*log(GDPS2)
+ 0.00000*log(wpri*(1+ssc)/pqS2)

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+ -0.14211*dumPCen + 0.00000*dumPCen(-4)
+ -0.084900*Q2 + 0.012053*Q3 + 0.077586*Q4);
FRML EQdl1nS2 lnS2 = exp(log(lnS2(-1))+0.49045*log(GDPS2/GDPS2(-1))
+ 0.00000*log((wpri*(1+ssc)/pqS2)/(wpri(-1)*(1+ssc(-1))/pqS2(-1)))
+ -0.14211*(dumPCen-dumPCen(-1)) + 0.00000*(dumPCen(-4)-dumPCen(-5))
- 0.52850*(log(lnS2(-1))-log(LRlnS2(-1)))+ADDJ*JDLNS2);
FRML EQ11nS3 LRlnS3 = exp(-2.41913 + -0.0068583*t + 1.00000*log(GDPS3)
+ 0.00000*log(wpri*(1+ssc)/pqS3)
+ 0.00000*dumPCen + -0.070001*dumPCen(-4)
+ 0.065334*Q2 + 0.0088723*Q3 + 0.14171*Q4);
FRML EQdl1nS3 lnS3 = exp(log(lnS3(-1))+1.28910*log(GDPS3/GDPS3(-1))
+ 0.00000*log((wpri*(1+ssc)/pqS3)/(wpri(-1)*(1+ssc(-1))/pqS3(-1)))
+ 0.00000*(dumPCen-dumPCen(-1)) + -0.070001*(dumPCen(-4)-dumPCen(-5))
- 0.80000*(log(lnS3(-1))-log(LRlnS3(-1)))+ADDJ*JDLNS3);
FRML EQ11nS4 LRlnS4 = exp(-0.87764 + -0.0070579*t + 1.00000*log(GDPS4)
+ 0.00000*log(wpub*(1+ssc)/pqS4)
+ -0.064053*dumPCen(-4) + 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQdl1nS4 lnS4 = exp(log(lnS4(-1))+0.065469*log(GDPS4/GDPS4(-1))
+ 0.00000*log((wpub*(1+ssc)/pqS4)/(wpub(-1)*(1+ssc(-1))/pqS4(-1)))
+ -0.064053*(dumPCen(-4)-dumPCen(-5))
- 0.10000*(log(lnS4(-1))-log(LRlnS4(-1)))+ADDJ*JDLNS4);

IDENT IdLnPRI LNPRI = LNA+LNMN+LNE+LNM1+LNM2+LNM3+LNM4+LNC+LNS1+LNS2+LNS3;
IDENT IDLNT LNT = LNPRI + LNS4;
IDENT IDln ln = 40*(lnA+lnmn+lnne+lnm1+lnm2+lnm3+lnm4+lnc+lns1+lns2+lns3+lns4)/workhour;
IDENT IDlnw LRln = 40*(LRlnA+LRlnmn+LRlnne+LRlnm1+LRlnm2+LRlnm3+LRlnm4+LRlnc
+LRlns1+LRlns2+LRlns3+LRlns4)/workhour;

? Wage sum
IDENT IDwsum WSUM = 0.001*3*WPUB*LNS4 + 0.001*3*WPRI*LNPRI;

? Labour supply
FRML EQ11s LRls = exp(-1.13767 + log(POP)+0.070435*(log((ntmin+(wpri-ntmin)*(1-tl))/pc) )
+-0.080698*(dumPCen(-8))+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQdl1s ls = exp(log(ls(-1))-0.43874*(log(LS(-1))-log(LRls(-1))) + log(POP/POP(-1))
+ 0.00000*(log((ntmin+(wpri-ntmin)*(1-tl))/pc)
-log((ntmin(-1)+(wpri(-1)-ntmin(-1))*(1-tl(-1)))/pc(-1)))
+ -0.080698*(dumPCen(-8) -dumPCen(-9))
+ 0.00000*(log(GDP/GDPwr)-log(GDP(-1)/GDPwr(-1)))+ADDJ*JDLS);

? Unemployment
IDENT IDu U = 1-LN/LS;
IDENT IDuw LRU = 1-LRLN/LRLS;

?-----
? *** INVESTMENTS ***

? Demand for capital investments in sectors
FRML EQ1irA LRirA = exp(-1.38592 + 0.00000*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPA)
+ 0.00000*log(pi/pqA) + 0.00000*ra
+ -2.36935*Q2 + -0.18496*Q3 + -4.25624*Q4);
FRML EQdlirA irA = exp(log(irA(-1))+0.62072*log(GDPA/GDPA(-1))
+ -0.66092*log((pi/pqA)/(pi(-1)/pqA(-1))) + 0.00000*(ra-ra(-1))
- 0.25122*(log(irA(-1))-log(LRirA(-1)))+ADDJ*JDIRA);
FRML EQ1irMN LRirMN = exp(0.072551 + -0.080965*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPMN)
+ -2.03550*log(pi/pqMN) + 0.00000*ra
+ -0.76585*Q2 + -0.20588*Q3 + -1.68970*Q4);
FRML EQdlirMN irMN = exp(log(irMN(-1))+0.66204*log(GDPMN/GDPMN(-1))
+ -0.93061*log((pi/pqMN)/(pi(-1)/pqMN(-1))) + 0.00000*(ra-ra(-1))
- 0.58619*(log(irMN(-1))-log(LRirMN(-1)))+ADDJ*JDIRMN);
FRML EQ1irE LRirE = exp(0.90746 + 0.00000*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPE)
+ 0.00000*log(pi/pqE) + -0.064711*ra
+ -0.15703*Q2 + 0.44174*Q3 + -2.72508*Q4);
FRML EQdlirE irE = exp(log(irE(-1))+0.26950*log(GDPE/GDPE(-1))
+ 0.00000*log((pi/pqE)/(pi(-1)/pqE(-1))) + 0.00000*(ra-ra(-1))
- 0.37270*(log(irE(-1))-log(LRirE(-1)))+ADDJ*JDIRE);
FRML EQ1irM1 LRirM1 = exp(-0.95855 + 0.00000*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPM1)
+ 0.00000*log(pi/pqM1) + -0.033919*ra
+ 0.17972*Q2 + 0.13195*Q3 + -0.94712*Q4);
FRML EQdlirM1 irM1 = exp(log(irM1(-1))+0.00000*log(GDPM1/GDPM1(-1))
+ 0.00000*log((pi/pqM1)/(pi(-1)/pqM1(-1))) + 0.00000*(ra-ra(-1))
- 0.51284*(log(irM1(-1))-log(LRirM1(-1)))+ADDJ*JDIRM1);
FRML EQ1irM2 LRirM2 = exp(-2.70493 + 0.033312*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPM2)
+ 0.00000*log(pi/pqM2) + 0.00000*ra
+ 0.42006*Q2 + 0.57512*Q3 + 0.018720*Q4);
FRML EQdlirM2 irM2 = exp(log(irM2(-1))+0.81250*log(GDPM2/GDPM2(-1))
+ 0.00000*log((pi/pqM2)/(pi(-1)/pqM2(-1))) + -0.11572*(ra-ra(-1))
- 0.75850*(log(irM2(-1))-log(LRirM2(-1)))+ADDJ*JDIRM2);
FRML EQ1irM3 LRirM3 = exp(-2.20635 + 0.022002*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPM3)
+ 0.00000*log(pi/pqM3) + 0.00000*ra

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+ -0.081251*Q2 + 0.45778*Q3 + -0.14785*Q4);
FRML EQdlirM3  irM3 = exp(log(irM3(-1))+1.24018*log(GDPM3/GDPM3(-1))
+ -0.31494*log((pi/pqM3)/(pi(-1)/pqM3(-1))) + -0.036559*(ra-ra(-1))
- 0.86238*(log(irM3(-1))-log(LRirM3(-1)))+ADDJ*JDIRM3);
FRML EQlirM4  LRirM4 = exp(-3.50788 + 0.069933*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPM4)
+ 0.00000*log(pi/pqM4) + 0.00000*ra
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQdlirM4  irM4 = exp(log(irM4(-1))+0.00000*log(GDPM4/GDPM4(-1))
+ 0.00000*log((pi/pqM4)/(pi(-1)/pqM4(-1))) + 0.00000*(ra-ra(-1))
- 0.90000*(log(irM4(-1))-log(LRirM4(-1)))+ADDJ*JDIRM4);
FRML EQlirC  LRirC = exp(-3.17157 + 0.052209*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPC)
+ 0.00000*log(pi/pqC) + -0.028038*ra
+ -0.50664*Q2 + 0.48878*Q3 + 0.26883*Q4);
FRML EQdlirC  irC = exp(log(irC(-1))+1.18703*log(GDPC/GDPC(-1))
+ -1.90367*log((pi/pqC)/(pi(-1)/pqC(-1))) + 0.00000*(ra-ra(-1))
- 0.82110*(log(irC(-1))-log(LRirC(-1)))+ADDJ*JDIRC);
FRML EQlirS1  LRirS1 = exp(-3.08072 + 0.041203*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPS1)
+ -1.72369*log(pi/pqS1) + 0.00000*ra
+ -0.075464*Q2 + 0.41920*Q3 + -0.37859*Q4);
FRML EQdlirS1  irS1 = exp(log(irS1(-1))+0.82635*log(GDPS1/GDPS1(-1))
+ 0.00000*log((pi/pqS1)/(pi(-1)/pqS1(-1))) + 0.00000*(ra-ra(-1))
- 0.90000*(log(irS1(-1))-log(LRirS1(-1)))+ADDJ*JDIRS1);
FRML EQlirS2  LRirS2 = exp(0.97547 + -0.060281*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPS2)
+ -1.45312*log(pi/pqS2) + -0.059083*ra
+ -0.021659*Q2 + 0.19533*Q3 + -0.64789*Q4);
FRML EQdlirS2  irS2 = exp(log(irS2(-1))+0.00000*log(GDPS2/GDPS2(-1))
+ 0.00000*log((pi/pqS2)/(pi(-1)/pqS2(-1))) + -0.031281*(ra-ra(-1))
- 0.90000*(log(irS2(-1))-log(LRirS2(-1)))+ADDJ*JDIRS2);
FRML EQlirS3  LRirS3 = exp(-2.96077 + 0.064016*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPS3)
+ 0.00000*log(pi/pqS3) + 0.00000*ra
+ -0.15737*Q2 + -0.091178*Q3 + -0.79347*Q4);
FRML EQdlirS3  irS3 = exp(log(irS3(-1))+0.00000*log(GDPS3/GDPS3(-1))
+ 0.00000*log((pi/pqS3)/(pi(-1)/pqS3(-1))) + 0.00000*(ra-ra(-1))
- 0.79561*(log(irS3(-1))-log(LRirS3(-1)))+ADDJ*JDIRS3);
FRML EQlirS4  LRirS4 = exp(-1.04631 + 0.00000*(t*D + t(2002:2)*(1-D)) + 1.00000*log(GDPS4)
+ 0.00000*log(pi/pqS4) + -0.033182*ra
+ -0.11380*Q2 + 0.28927*Q3 + -1.28942*Q4);
FRML EQdlirS4  irS4 = exp(log(irS4(-1))+0.00000*log(GDPS4/GDPS4(-1))
+ 0.00000*log((pi/pqS4)/(pi(-1)/pqS4(-1))) + 0.00000*(ra-ra(-1))
- 0.68022*(log(irS4(-1))-log(LRirS4(-1)))+ADDJ*JDIRS4);

IDENT IDirt  IRT  = IRA+IRMN+IRE+IRM1+IRM2+IRM3+IRM4+IRC+IRS1+IRS2+IRS3+IRS4;
IDENT IDirth IRT  = IRT + IRH;

FRML EQlirnl irnl = 540.97765 + 1.00000*irth + 0.55306*(FDI/PI) + 0.00000*GDPT
+ -245.01794*DUMRC(-1)+ 217.32839*Q2+ 467.10658*Q3 + -162.97665*Q4
+ ADDJ*LIRN1;

? Capital stock
IDENT IDcaprt CAPRt = CAPRt(-1)*(1-delta) + IRT;

? Profit
IDENT IDproff PROF = QVT - INVT*(1+TP) - WSUM*(1+SSC) - PI*IRT;

?-----
? *** PRICES ***

? Unit cost, production in sectors
IDENT IDpqucA  pqucA = ((1+TP)*PINA*INRA + 0.001*3*(1+SSC)*WPRI*LNA + PI*IRA )/QRA;
IDENT IDpqucMN pqucMN = ((1+TP)*PINMN*INRMN + 0.001*3*(1+SSC)*WPRI*LNMN + PI*IRMN)/QRMN;
IDENT IDpqucE  pqucE = ((1+TP)*PINE*INRE + 0.001*3*(1+SSC)*WPRI*LNE + PI*IRE )/QRE;
IDENT IDpqucM1 pqucM1 = ((1+TP)*PINM1*INRM1 + 0.001*3*(1+SSC)*WPRI*LN1 + PI*IRM1)/QRM1;
IDENT IDpqucM2 pqucM2 = ((1+TP)*PINM2*INRM2 + 0.001*3*(1+SSC)*WPRI*LN2 + PI*IRM2)/QRM2;
IDENT IDpqucM3 pqucM3 = ((1+TP)*PINM3*INRM3 + 0.001*3*(1+SSC)*WPRI*LN3 + PI*IRM3)/QRM3;
IDENT IDpqucM4 pqucM4 = ((1+TP)*PINM4*INRM4 + 0.001*3*(1+SSC)*WPRI*LN4 + PI*IRM4)/QRM4;
IDENT IDpqucC  pqucC = ((1+TP)*PINC*INRC + 0.001*3*(1+SSC)*WPRI*LNC + PI*IRC )/QRC;
IDENT IDpqucS1 pqucS1 = ((1+TP)*PINS1*INRS1 + 0.001*3*(1+SSC)*WPRI*LNS1 + PI*IRS1)/QRS1;
IDENT IDpqucS2 pqucS2 = ((1+TP)*PINS2*INRS2 + 0.001*3*(1+SSC)*WPRI*LNS2 + PI*IRS2)/QRS2;
IDENT IDpqucS3 pqucS3 = ((1+TP)*PINS3*INRS3 + 0.001*3*(1+SSC)*WPRI*LNS3 + PI*IRS3)/QRS3;
IDENT IDpqucS4 pqucS4 = ((1+TP)*PINS4*INRS4 + 0.001*3*(1+SSC)*WPUB*LNS4 + PI*IRS4)/QRS4;

? Output price in sectors, PQ{j}
FRML EQLPQA  LRPQA = exp(0.51392*log(pqucA) + (1-0.51392)*log(pm)
+ 0.19099 + 0.00000*(t(-1)*D + t(2002:2)*(1-D))
+ 0.12248*Q2 + -0.18757*Q3 + 0.00095907*Q4);
FRML EQDLPQA PQA = exp(log(pqA(-1))+0.66689*(log(LRpqa(-1))-log(pqA(-1)))
+ 0.67937*log(pqucA/pqucA(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQA);
FRML EQLPQM1  LRPQM1 = exp(0.64929*log(pqucM1) + (1-0.64929)*log(pm)
+ 0.066640 + 0.0055989*(t(-1)*D + t(2002:2)*(1-D))

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+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQDLPQM1 PQM1 = exp(log(pqM1(-1))+0.47221*(log(LRpqM1(-1))-log(pqM1(-1)))
+ 0.94606*log(pqucM1/pqucM1(-1))
+ 0.71878*log(pm/pm(-1))+ADDJ*JDPQM1);
FRML EQLPQM2 LRPQM2 = exp(0.60029*log(pqucM2) + (1-0.60029)*log(pm)
+ 0.033134 + 0.0069663*(t(-1)*D + t(2002:2)*(1-D))
+ -0.043659*Q2 + -0.088019*Q3 + -0.011584*Q4);
FRML EQDLPQM2 PQM2 = exp(log(pqM2(-1))+0.66039*(log(LRpqM2(-1))-log(pqM2(-1)))
+ 0.92985*log(pqucM2/pqucM2(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQM2);
FRML EQLPQM3 LRPQM3 = exp(1.00000*log(pqucM3) + (1-1.00000)*log(pm)
+ 0.071507 + 0.0031465*(t(-1)*D + t(2002:2)*(1-D))
+ 0.028214*Q2 + -0.080384*Q3 + 0.016296*Q4);
FRML EQDLPQM3 PQM3 = exp(log(pqM3(-1))+0.47964*(log(LRpqM3(-1))-log(pqM3(-1)))
+ 1.03947*log(pqucM3/pqucM3(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQM3);
FRML EQLPQM4 LRPQM4 = exp(0.63772*log(pqucM4) + (1-0.63772)*log(pm)
+ 0.024343 + 0.0086052*(t(-1)*D + t(2002:2)*(1-D))
+ 0.030388*Q2 + -0.14565*Q3 + 0.088843*Q4);
FRML EQDLPQM4 PQM4 = exp(log(pqM4(-1))+0.30761*(log(LRpqM4(-1))-log(pqM4(-1)))
+ 1.04372*log(pqucM4/pqucM4(-1))
+ 0.76415*log(pm/pm(-1))+ADDJ*JDPQM4);
FRML EQLPQC LRPQC = exp(0.39989*log(pqucC) + (1-0.39989)*log(pm)
+ 0.34240 + 0.00000*(t(-1)*D + t(2002:2)*(1-D))
+ 0.042287*Q2 + -0.030218*Q3 + -0.058116*Q4);
FRML EQDLPQC PQC = exp(log(pqC(-1))+0.17782*(log(LRpqC(-1))-log(pqC(-1)))
+ 0.00000*log(pqucC/pqucC(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQC);
FRML EQLPQS2 LRPQS2 = exp(0.42322*log(pqucS2) + (1-0.42322)*log(pm)
+ 0.075945 + 0.014501*(t(-1)*D + t(2002:2)*(1-D))
+ -0.034227*Q2 + -0.087086*Q3 + 0.048525*Q4);
FRML EQDLPQS2 PQS2 = exp(log(pqS2(-1))+0.55292*(log(LRpqS2(-1))-log(pqS2(-1)))
+ 0.47607*log(pqucS2/pqucS2(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQS2);
FRML EQLPQS3 LRPQS3 = exp(0.57232*log(pqucS3) + (1-0.57232)*log(pm)
+ 0.56173 + 0.00000*(t(-1)*D + t(2002:2)*(1-D))
+ -0.049913*Q2 + 0.0060095*Q3 + -0.11030*Q4);
FRML EQDLPQS3 PQS3 = exp(log(pqS3(-1))+0.55053*(log(LRpqS3(-1))-log(pqS3(-1)))
+ 0.15966*log(pqucS3/pqucS3(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQS3);
FRML EQLPQS4 LRPQS4 = exp(0.86657*log(pqucS4) + (1-0.86657)*log(pm)
+ 0.13954 + 0.0043364*(t(-1)*D + t(2002:2)*(1-D))
+ -0.099195*Q2 + -0.056819*Q3 + -0.056858*Q4);
FRML EQDLPQS4 PQS4 = exp(log(pqS4(-1))+0.89898*(log(LRpqS4(-1))-log(pqS4(-1)))
+ 0.71306*log(pqucS4/pqucS4(-1))
+ 0.00000*log(pm/pm(-1))+ADDJ*JDPQS4);

FRML EQLPQMN PQMN = exp(0.68564*log(pqucMN) + (1-0.68564)*log(pm)
+ 0.010366 + 0.019697*(t(-1)*D + t(2002:2)*(1-D))
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);
FRML EQLPQE PQE = exp(0.85159*log(pqucE) + (1-0.85159)*log(pm)
+ 0.14742 + 0.0041599*(t(-1)*D + t(2002:2)*(1-D))
+ -0.12552*Q2 + -0.14002*Q3 + -0.11850*Q4);
FRML EQLPQS1 PQS1 = exp(0.56381*log(pqucS1) + (1-0.56381)*log(pm)
+ 0.35812 + 0.00000*(t(-1)*D + t(2002:2)*(1-D))
+ 0.022626*Q2 + 0.027853*Q3 + -0.0068634*Q4);

IDENT EQPQAG PQ = (PQA*QRA+PQMN*QRMN+PQE*QRE+PQM1*QRM1+PQM2*QRM2+PQM3*QRM3+PQM4*QRM4
+PQC*QRC+PQS1*QRS1+PQS2*QRS2+PQS3*QRS3+PQS4*QRS4)/QRT;
IDENT EQPQM PQM = (PQM1*QRM1+PQM2*QRM2+PQM3*QRM3+PQM4*QRM4)/QRM;
IDENT EQPQS PQS = (PQS1*QRS1+PQS2*QRS2+PQS3*QRS3+PQS4*QRS4)/QRS;

? Price on intermediate in sectors, PIN{j}
FRML EQLPINA PINA = exp(-0.0049811
+ 1.00*(log(0.045000*PQA+0.0020000*PQMN+0.027000*PQE
+0.039000*PQM1+0.020000*PQM2+0.015000*PQM3
+0.0010000*PQM4+0.0090000*PQC+0.25400*PQS1
+0.058000*PQS2+0.033000*PQS3+0.00000*PQS4)
-log(0.045000+0.0020000+0.027000+0.039000
+0.020000+0.015000+0.0010000+0.0090000
+0.25400+0.058000+0.033000+0.00000))
+ -0.026485*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.033695*Q2 + -0.14936*Q3 + 0.028550*Q4 + ADDJ*JLPINA);
FRML EQLPINMN PINMN = exp(-0.44432
+ 1.00*(log(0.00000*PQA+0.041000*PQMN+0.044000*PQE
+0.023000*PQM1+0.071000*PQM2+0.0060000*PQM3
+0.00000*PQM4+0.0090000*PQC+0.26000*PQS1
+0.063000*PQS2+0.028000*PQS3+0.0010000*PQS4)
-log(0.00000+0.041000+0.044000+0.023000
+0.071000+0.0060000+0.00000+0.0090000

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+0.26000+0.063000+0.028000+0.0010000))
+ 0.016876*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.11618*Q2 + 0.20473*Q3 + 0.11023*Q4 + ADDJ*JLPINMN);
FRML EQLPINE PINE = exp(0.027809
+ 1.00*(log(0.00000*PQA+0.0010000*PQMN+0.40000*PQE
+0.027000*PQM1+0.027000*PQM2+0.0050000*PQM3
+0.0010000*PQM4+0.0040000*PQC+0.0090000*PQS1
+0.0060000*PQS2+0.065000*PQS3+0.0010000*PQS4)
-log(0.00000+0.0010000+0.40000+0.027000
+0.027000+0.0050000+0.0010000+0.0040000
+0.0090000+0.0060000+0.065000+0.0010000))
+ -0.015131*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4 + ADDJ*JLPINE);
FRML EQLPINM1 PINM1 = exp(-0.21919
+ 1.00*(log(0.00000*PQA+0.021000*PQMN+0.092000*PQE
+0.13200*PQM1+0.037000*PQM2+0.019000*PQM3
+0.0020000*PQM4+0.015000*PQC+0.20000*PQS1
+0.090000*PQS2+0.034000*PQS3+0.0010000*PQS4)
-log(0.00000+0.021000+0.092000+0.13200
+0.037000+0.019000+0.0020000+0.015000
+0.20000+0.090000+0.034000+0.0010000))
+ 0.00000*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.10185*Q2 + 0.063540*Q3 + 0.22244*Q4 + ADDJ*JLPINM1);
FRML EQLPINM2 PINM2 = exp(0.052934
+ 1.00*(log(0.00000*PQA+0.0010000*PQMN+0.048000*PQE
+0.15400*PQM1+0.17700*PQM2+0.036000*PQM3
+0.0030000*PQM4+0.011000*PQC+0.14700*PQS1
+0.057000*PQS2+0.029000*PQS3+0.0010000*PQS4)
-log(0.00000+0.0010000+0.048000+0.15400
+0.17700+0.036000+0.0030000+0.011000
+0.14700+0.057000+0.029000+0.0010000))
+ -0.0054144*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ -0.024976*Q2 + -0.10989*Q3 + -0.16130*Q4 + ADDJ*JLPINM2);
FRML EQLPINM3 PINM3 = exp(-0.12645
+ 1.00*(log(0.32400*PQA+0.00000*PQMN+0.034000*PQE
+0.022000*PQM1+0.033000*PQM2+0.049000*PQM3
+0.0010000*PQM4+0.011000*PQC+0.12000*PQS1
+0.044000*PQS2+0.017000*PQS3+0.00000*PQS4)
-log(0.32400+0.00000+0.034000+0.022000
+0.033000+0.049000+0.0010000+0.011000
+0.12000+0.044000+0.017000+0.00000))
+ 0.0042796*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.028418*Q2 + 0.092760*Q3 + 0.12197*Q4 + ADDJ*JLPINM3);
FRML EQLPINM4 PINM4 = exp(-0.12343
+ 1.00*(log(0.0070000*PQA+0.0010000*PQMN+0.061000*PQE
+0.050000*PQM1+0.067000*PQM2+0.057000*PQM3
+0.065000*PQM4+0.0100000*PQC+0.19000*PQS1
+0.054000*PQS2+0.040000*PQS3+0.0010000*PQS4)
-log(0.0070000+0.0010000+0.061000+0.050000
+0.067000+0.057000+0.065000+0.0100000
+0.19000+0.054000+0.040000+0.0010000))
+ 0.00000*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4 + ADDJ*JLPINM4);
FRML EQLPINC PINC = exp(0.016021
+ 0.16258*(log(0.00000*PQA+0.021000*PQMN+0.015000*PQE
+0.24300*PQM1+0.016000*PQM2+0.023000*PQM3
+0.00000*PQM4+0.065000*PQC+0.0040000*PQS1
+0.11300*PQS2+0.011000*PQS3+0.00000*PQS4)
-log(0.00000+0.021000+0.015000+0.24300
+0.016000+0.023000+0.00000+0.065000
+0.0040000+0.11300+0.011000+0.00000))
+ 0.0033908*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ -0.0012316*Q2 + 0.035177*Q3 + 0.016809*Q4 + ADDJ*JLPINC);
FRML EQLPINS1 PINS1 = exp(0.048248
+ 1.00*(log(0.022000*PQA+0.00000*PQMN+0.033000*PQE
+0.031000*PQM1+0.022000*PQM2+0.086000*PQM3
+0.00000*PQM4+0.0080000*PQC+0.10300*PQS1
+0.00000*PQS2+0.043000*PQS3+0.00000*PQS4)
-log(0.022000+0.00000+0.033000+0.031000
+0.022000+0.086000+0.00000+0.0080000
+0.10300+0.00000+0.043000+0.00000))
+ 0.0018712*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ -0.013941*Q2 + -0.012594*Q3 + -0.049312*Q4 + ADDJ*JLPINS1);
FRML EQLPINS2 PINS2 = exp(0.011702
+ 1.00*(log(0.0010000*PQA+0.0040000*PQMN+0.11600*PQE
+0.022000*PQM1+0.066000*PQM2+0.019000*PQM3
+0.0010000*PQM4+0.0030000*PQC+0.023000*PQS1
+0.19400*PQS2+0.024000*PQS3+0.00000*PQS4)
-log(0.0010000+0.0040000+0.11600+0.022000
+0.066000+0.019000+0.0010000+0.0030000

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+0.023000+0.19400+0.024000+0.00000))
+ -0.0075649*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.047711*Q2 + 0.060252*Q3 + 0.11238*Q4 + ADDJ*JLPINS2);
FRML EQLPINS3 PINS3 = exp(-0.040525
+ 1.00*(log(0.0010000*PQA+0.00000*PQMN+0.012000*PQE
+0.00000*PQM1+0.0020000*PQM2+0.013000*PQM3
+0.00000*PQM4+0.011000*PQC+0.053000*PQS1
+0.035000*PQS2+0.14900*PQS3+0.00000*PQS4)
-log(0.0010000+0.00000+0.012000+0.00000
+0.0020000+0.013000+0.00000+0.011000
+0.053000+0.035000+0.14900+0.00000))
+ 0.00000*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ 0.020802*Q2 + 0.018905*Q3 + 0.057765*Q4 + ADDJ*JLPINS3);
FRML EQLPINS4 PINS4 = exp(0.014540
+ 1.00*(log(0.00000*PQA+0.00000*PQMN+0.029000*PQE
+0.036000*PQM1+0.00000*PQM2+0.00000*PQM3
+0.00000*PQM4+0.082000*PQC+0.00000*PQS1
+0.038000*PQS2+0.16700*PQS3+0.017000*PQS4)
-log(0.00000+0.00000+0.029000+0.036000
+0.00000+0.00000+0.00000+0.082000
+0.00000+0.038000+0.16700+0.017000))
+ 0.0038884*(t(-1)*D + t(2002:2)*(1-D)) + 0.00000*log(pm)
+ -0.036583*Q2 + -0.047711*Q3 + -0.067353*Q4 + ADDJ*JLPINS4);

IDENT IDpint PINT = INVT/INRT;

? GDP deflator
FRML EQpgdp pgdp = 1.01368*(QVT-INVT)/GDPT
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4 + ADDJ*J_PGDP;

? Consumer price, PC
FRML EQLPC LRPC = exp(-0.197270 + log(1+vat) +0.030971*Q2+-0.015489*Q3+0.062859*Q4
+ 0.00000*log(pqa) + 0.00000*log(pqe) + 0.00000*log(pqm)
+ 0.748283*log(pqs) + (1-0.00000-0.00000-0.00000-0.748283)*log(pm));
FRML EQDLPC PC = exp(log(pc(-1))+ -0.411579*(log(pc(-1))-log(LRPC(-1)))
+ 0.00000*log(pqa/pqa(-1))
+ 0.00000*log(pqe/pqe(-1))
+ 0.00000*log(pqm/pqm(-1))
+ 0.820106*log(pqs/pqs(-1))
+(1-0.00000-0.00000-0.00000-0.820106)*log(pm/pm(-1))
+ log((1+vat)/(1+vat(-1)))+ADDJ*JDPC);

? Price on public consumption, PCG
FRML EQLPCG LRPCG = exp(0.053328 + 1.00000*log(pqs4)
+-0.034873*Q2+-0.0056429*Q3+0.032378*Q4);
FRML EQDLPCG PCG = exp(log(PCG(-1))+0.69282*(log(pcg(-1))-log(LRPCG(-1)))
+ 0.57263*log(pqs4/pqs4(-1))+ADDJ*JDPCG);

? Price on investment, PI
FRML EQLPI LRPI = exp(0.18849 + 0.00000*log(pqm2) + 0.00000*log(pqc)
+ (1-0.00000-0.00000)*log(pm) + -0.0062636*ra
+ 0.00000*dumRC +0.00000*Q2+0.00000*Q3+0.00000*Q4);
FRML EQDLPI PI = exp(log(PI(-1))+0.25312*(log(pi(-1))-log(LRPI(-1)))
+ 0.00000*log((pqm2)/(pqm2(-1)))
+ 0.53842*log((pqc)/(pqc(-1)))
+ (1-0.00000-0.53842)*log((pm)/(pm(-1)))
+ 0.00000*(ra-ra(-1))
+ 0.00000*(dumRC-dumRC(-1))+ADDJ*JDPI);

? Export price, PX
IDENT IDpqex pqex = 0.11000*PQA + 0.0040000*PQMN + 0.12000*PQE + 0.16000*PQM1
+ 0.11300*PQM2 + 0.23300*PQM3 + 0.017000*PQM4 + 0.015000*PQC
+ 0.11000*PQS1 + 0.095000*PQS2 + 0.022000*PQS3 + 0.00000*PQS4;
FRML eqlpx px = exp(-0.011933 + (0.63500*log(pqex) + 0.16571*log(pwreu) + 0.052584*log(pwrce)
+ (1-0.63500-0.16571-0.052584)*log(pwrce))
+ 0.00000*Q2 + 0.00000*Q3 + 0.00000*Q4);

? 'World market price' in LTL (normalize to 1 in 1995:1)
IDENT IDpwreu pwreu = (pwreu/reereu)/(pwreu(1995:1)/reereu(1995:1));
IDENT IDpwrce pwrce = (pwrce/reerce)/(pwrce(1995:1)/reerce(1995:1));
IDENT IDWMP wmp = 0.64*pwreu + 0.26*pwrce + 0.10*pwrce;

?-----
? *** WAGES ***

? Wage in private sector
FRML EQLwpri LRwpri = exp(5.89872 - log(1+ssc)
+ 0.84044*log(GDPpri/LNpri) + 1.00000*log(pc) + -5.36126*U
+ -0.22457*Q2 + -0.23949*Q3 + -0.38280*Q4);

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FRML EQdlwpri wpri = exp(log(wpri(-1))+0.20908*(log(LRwpri(-1))-log(wpri(-1)))
+ 0.00000*(log(GDPpri/LNpri)-log(GDPpri(-1)/LNpri(-1)))
+ 0.33358*log(pc/pc(-1))- log((1+ssc)/(1+ssc(-1)))
+ 0.00000*(U-U(-1))+ADDJ*JDWPRI);

? Wage in public sector
FRML EQlwpub wpub = exp(-0.045328 + 1.00000*log(wpri)
+ 0.57112*(log(wpub(-1))
--0.045328-1.00000*log(wpri(-1)))+ADDJ*JLWPUB);

?-----
? ***      END of EQUATIONS      ***
?-----

? ADDJ is global shift parameter to include or exclude all J-factors
SET ADDJ = 0;

? LISTS of equations in the sub-models
? FRML: EQ estimated
? IDENT: ID identities

LIST eqhouse IDdi EQlcrn EQlirh IDcv Eqdlcrn;

LIST (prefix=IDcgrev) idcg w,p,v,s;
LIST eqgov idca idcg idsscin idcgrev idgdef eqlpens idcgsev idcgw ;

LIST (prefix=eqlln) eqlln C,MN,A,E,M1,M2,M3,M4,S1,S2,S3,S4;
LIST (prefix=eqdlln) eqdlln C,MN,A,E,M1,M2,M3,M4,S1,S2,S3,S4;
LIST eqlabour IdLnPRI IDLNT Idlnw Idln IDu Eqdlls EQlls eqdlln eqlln;

LIST (prefix=eqqr) eqqr12 T,M,S,A,MN,E,M1,M2,M3,M4,C,S2,S3,S1,S4;
LIST (prefix=idai) idai A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;
LIST (prefix=eqinr) eqinr T,A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;
LIST (prefix=eqgdp) eqgdp T,PRI,VT,A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;
LIST eqproduction idai eqqr12 idqvt eqinr eqinv eqgdp IDGDP1 IDGDP2;

LIST (prefix=eqlir) eqlir C,MN,A,E,M1,M2,M3,M4,S1,S2,S3,S4;
LIST (prefix=eqdlir) eqdlir C,MN,A,E,M1,M2,M3,M4,S1,S2,S3,S4;
LIST eqinvest eqlir eqdlir idirth idirt;

LIST eqincome IDprof EQlwpri EQdlwpri EQlwpub IDwsum;

LIST (prefix=eqdlpq) eqdlpq A, M1,M2,M3,M4,C, S2,S3,S4;
LIST (prefix=eqlpq) eqlpq A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;
LIST (prefix=idpquc) eqpquc A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;
LIST (prefix=eqlpin) eqlpin A,MN,E,M1,M2,M3,M4,C,S1,S2,S3,S4;

LIST eqcapital IDcaprt Eqlirnl;

LIST eqprices EQPQAG eqpquc eqlpi eqdlPI eqlpx eqlpcg eqdlpcg eqpgdp
idpqex EQPQM EQPQS eqlpin idpint eqdlPC eqlpc eqdlpq eqlpq;

LIST eqforeign eqlmrn eqdlmrn eqlxrn eqdlxrn idwmp idpwreu idpwrci idpwrc;

? The order of the sub-models should NOT be changed!
LIST eq eqproduction,eqprices,eqinvest,eqlabour,eqincome,eqhouse,eqforeign,eqgov,eqcapital;

? The model is generated with the specified equations (list eq)
MODEL eq litmod;

?-----
? ***      END OF FILE      ***
?-----

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13. List of References

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